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The Southern Pacific Locomotive Boiler Explosion at San Antonio, Texas

An investigation of the locomotive-boiler explosion at San Antonio, Tex., on Mar. 18, 1912, has been recently completed by the inspectors of the Interstate Commerce Commission. This explosion occurred while the locomotive (No. 704, of the Galveston, Harrisburg & San Antonio Ry.) was standing in the Southern Pacific yard between the blacksmith shop and the copper shop. It had been in the shop for several days and was being prepared for service. Due to its proximity to the shops, which were alive with workmen, the loss of life was unusually high—26 persons being killed and 32 others injured.

Cause of the Explosion

According to the testimony before the investigating committee, the locomotive was out of service from Feb. 21 to Mar. 18. Repairs were made during this period as follows: 200 flues were reset, 1 backhead brace repaired, 1 front flue-sheet brace repaired, 2 throat stays repaired, 8 stay-bolts renewed. In addition, the safety valves were reground, the steam gage tested, and the boiler subjected to a hydrostatic pressure of 250 lb. per sq.in.

An employee of the railway company was engaged in setting the three safety valves of the locomotive at the time of the explosion, and in the opinion of the investigating committee, the accident was due to excessive steam pressure resulting from over-tightening of the safety-valve adjusting screws. It was found impossible, after the explosion, to test the pressure for which the valves had been set because of their damaged condition. But the condition of the adjusting-screw threads indicated that they had been recently screwed down more than 5/8 in. The corners of the hexagon screw heads had been twisted off and the marks on the heads showed that a pipe wrench had been used to still further tighten the screws.

According to the testimony of witnesses, the valves opened twice during the hour and a half preceding the ex-

FIG. 1. THE WRECKED LOCOMOTIVE AFTER THE EXPLOSION AT THE SOUTHERN PACIFIC YARDS IN SAN ANTONIO, TEX., MAR. 18

(View from rear end, showing crown sheet and firebox sheets blown down between frames.)

plosion—first at 50 lb. pressure and again, after having been screwed down, at 150 lb. pressure, as indicated by the locomotive's steam gage. The working pressure for this locomotive was 200 lb. This second opening of the safety valve occurred about 55 min. before the explosion. Presumably, the valves were then screwed down still further and the explosion followed.

The investigating committee concludes that the steam gage did not correctly indicate the pressure. The evidence showed the steam gage had been recently tested, but there was no evidence that the siphon pipe between the gage and the boiler had been cleaned nor any evidence to show that the valves in this pipe were open. The steam gage and its connections were destroyed by the explosion.

A report stating that the safety valves had been set was sworn to on Mar. 16 by the railway company's inspector and by the roundhouse foreman. As shown by the evidence, however, the valves had not been set on that date, but were being adjusted at the time of the explosion, two days later. Moreover it was shown that the inspector failed to witness the testing of the steam gage and that the injectors had not been tested at the time his report had been made out. Nevertheless he certified under oath that this work had been done.

How the Boiler Failed

At the time of the accident, it was persistently rumored that the explosion was primarily one of nitroglycerin or other high explosive placed by strikers, and at the time of the investigation the question was raised by some as to whether excessive steam pressure could cause such complete destruction. Nothing was found, however, to support the nitroglycerin theory, and in regard to the violence of the explosion, the investigating committee states that the water level was high, the pressure extremely high and the energy stored in the boiler tremendous.

The examination of the remains of the locomotive showed conclusively that the first parts of the boiler to fail were the sling stays holding the crown-sheet (which forms the roof of the firebox) to the outside or wrapper-sheet above. The crown-sheet, together with the firebox side-sheet and half of the door-sheet, was blown down between the frames. The greater part of the wrapper-sheet (a piece about 21x11 ft.) with the steam dome and a portion of the dome course attached to it was blown ahead and to the right a distance of 1200 ft. The aggregate weight of this fragment was about 16,000 lb.

Fig. 2. Fragment of Crown Sheet with Bars and Sling Stays Attached

The locomotive frame was spread apart at the rear end, as shown in Fig. 1, and both of the rear drivers were forced from the axle, while the main driving wheel was started but not forced completely off. The left rear driver was forced off with such violence that it was thrown out and toward the front of the engine, swinging around at the end of the driving rod. This rod, which can be seen at *C* in Fig. 1, was bent through an angle of more than 90°.

The forward part of the boiler (consisting of the smoke box and front flue-sheets; parts of the first, second and third courses of the boiler barrel; the back flue-sheet and throat-sheet, and about 150 of the boiler's 355 flues) was torn from the locomotive frame, and thrown about 25 ft. forward, where it landed bottom up. The smoke box with flues attached can be seen in the middle background of Fig. 1.

The Defective Sling Stays

A number of the crown-sheet sling stays can be seen in Fig. 1, hanging to the crumpled crown-sheet, where it lies between the frames. Fig. 2 shows a better view of the upper side of the crown-sheet, with four of the crown bars and a number of the stays still attached. In both of these views it is evident that the stays failed by pulling off from the bolts which held them to the bars on the wrapper-sheet. The eyes of the stays simply opened out and let go of the bolts. These sling stays were badly stretched and reduced in section at the eyes where they failed (Fig. 3), indicating a gradual rise in pressure in the boiler. A careful examination revealed that the stays were of wrought iron, instead of the steel called for in the specifications.

The crown-sheet was supported by 15 crown bars in all. These were not sup-

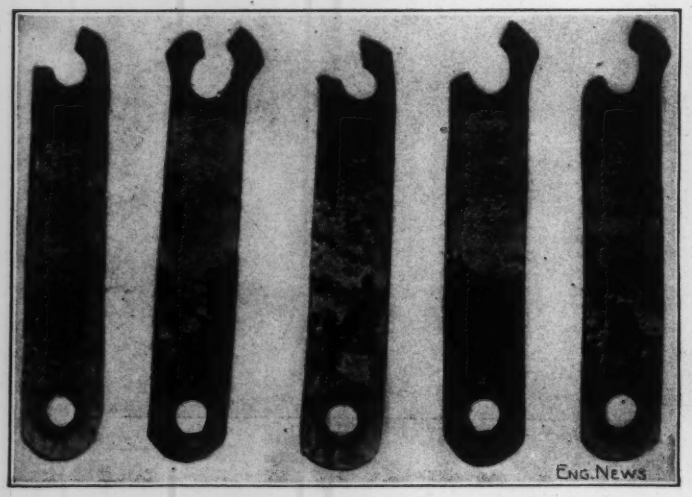

Fig. 3. Crown-Bar Sling Stays Taken from Wreckage, Showing Manner of Failure

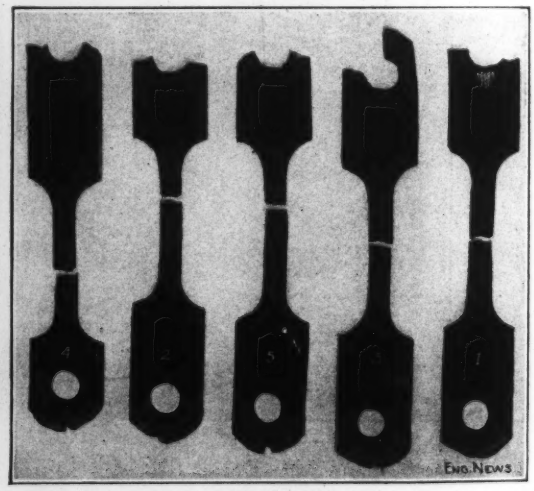

Fig. 4. The Sling Stays of Fig. 3 After the Total-Strength and Tensile Tests

(Stays were first tested for holding strength with bolts through their eyes. In every case they failed at the eyes, as shown. They were then reduced in section and tested for tensile strength.)

ported on the side of the firebox, as was customary in the older type of crown-bar boilers, but derived all their support from the sling stays anchoring them to the wrapper-sheet. There were 180 of these stays in all: 168 were ⅝ in. x 3 in. in section and the remaining 12 were ½ in. x 2¾ in.

The bolts holding the stays to the crown bars were in double shear, the stays being arranged in pairs, as can be seen in Fig. 2. The drawings for this boiler, which was built in March, 1908, by the American Locomotive Co. at its Brooks works, called for 1¼-in. bolts except for the front crown bars, where 1-in. bolts were specified. A number of 1-in. bolts were found in the investigation of the wreck where 1¼-in. bolts should have been used.

Five crown-bar sling stays taken from the wreck were tested by the U. S. Bureau of Standards to determine what loads they would support when fitted with 1-in. bolts and when fitted with 1¼-in. bolts. The results of these tests were as follows:

TESTS WITH 1-IN. BOLTS

No. 1 stay failed with total load of 21,840 lb.
No. 2 stay failed with total load of 26,650 lb.

TESTS WITH 1¼-IN. BOLTS

No. 3 stay failed with total load of 30,000 lb.
No. 4 stay failed with total load of 33,890 lb.
No. 5 stay failed with total load of 31,620 lb.

The bolts used in making these tests were taken from those in use in the boiler at the time of the explosion. The factor of safety with 1-in. bolts (assuming 200 lb. working pressure) was computed to be 2.67 for the strength shown by stay No. 1 and only 3.26 for the higher test figure of No. 2. The results of the tests with 1¼-in. bolts indicate factors of safety of 3.67 to 4.15.

The manner of failure of these stays under test is shown in Fig. 4. It is evident that the bolt holes were drilled too near the end. This photograph (Fig. 4) shows the stays as they appeared after having been reduced in section for the tensile tests of their material. These latter tests showed a tensile strength of from 43,200 to 48,300 lb. per sq.in., with an elongation in 2 in. of 18%—40½%.

The report of the investigation, which is signed by Chief Inspector John F. Ensign and Assistant Chief Inspectors Frank McManamy and G. P. Robinson, concludes as follows:

The railway company was at fault in requiring or permitting inspections and reports to be made in a manner which was not in accordance with the law, and in allowing such important and responsible work as setting safety valves to be performed by an employee of whose experience and judgment the testimony shows they knew practically nothing, and in keeping a boiler in service for which the factor of safety, as shown by test, was below the recognized standard.

The rules governing the inspection of locomotive boilers, setting of safety valves, testing of gages and similar work are sufficiently comprehensive to insure safety if properly and intelligently complied with.

However, in endeavoring to obviate a recurrence of an accident of this character the necessary action has been taken making the use of two steam gages obligatory when setting safety valves, one of which must be so connected that it is in full view of the person engaged in setting such safety valves. Similar action has also been taken requiring the siphon pipe and its connections to the boiler to be cleaned each time the gage is tested.

Street Bridges over the Great Northen Ry. Tracks in Minneapolis

BY O. B. ROBBINS*

Within the past two years the Great Northern Ry. has designed and constructed in Minneapolis three overhead street crossings that embody some distinctive features of bridge design. They carry respectively Superior Ave., University Ave., and the intersection of Fifteenth Ave. and Fourth St., over the tracks of the Great Northern.

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SUPERIOR AVE. BRIDGE

The Superior Ave. bridge crosses the tracks of both the Great Northern Ry. and the Minneapolis and St. Louis Ry. It is designed for ordinary street loads, 100 lbs. per sq.ft. on the sidewalks and roadway with 25% impact added on the roadway and a 16-ton traction engine used as alternate roadway load with slightly increased stresses. The stresses allowed for the uniform load plus impact were 16,000 lbs. per sq.in. for steel in tension, and 2200 lbs. per sq.in. for creosoted timber in bending. A wind pressure of 50 lbs. per sq.ft. on 1½ times the exposed surface (as seen in elevation) was used in the design of laterals and piers.

The bridge is of through girder construction, with 28-ft. roadway; two walks about 6 ft. wide lie outside the girders. The roadway consists of 4-in. creosoted block paving, resting on 6-in. creosoted planking, which is in turn supported by steel floorbeams running from girder to girder. These floorbeams are rolled I-beams, spaced about 9 ft. on centers. The sidewalks are reinforced-concrete slabs resting on steel brackets placed at the points of floorbeam connection.

The angles formed by the center line of Superior Ave. and the center lines of tracks vary from 15° 36′ to about 22°. The extreme sharpness of these angles

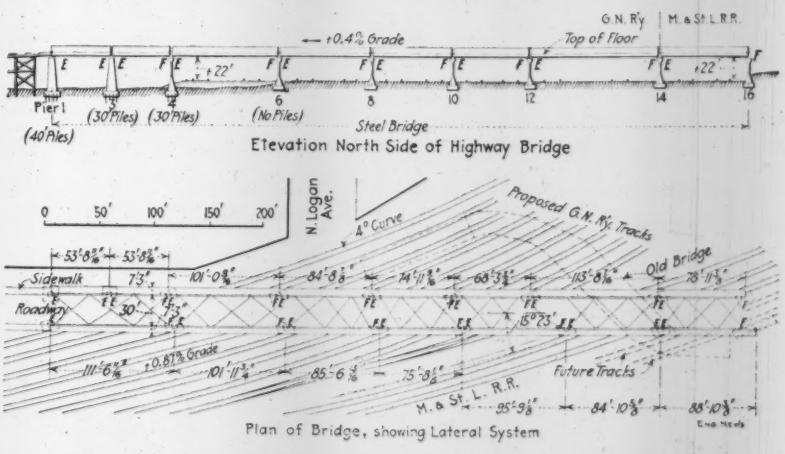

FIG. 1. GENERAL PLAN AND ELEVATION OF SUPERIOR AVE. BRIDGE

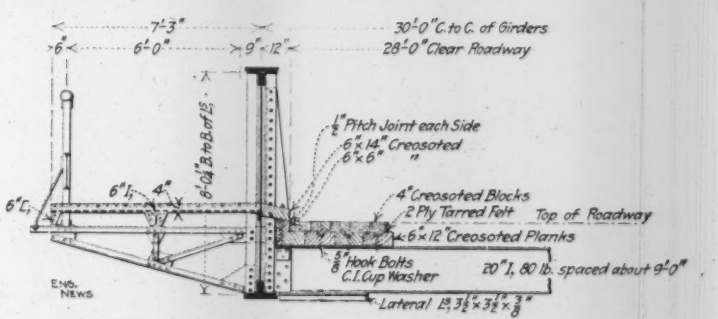

FIG. 2. HALF CROSS-SECTION OF SUPERIOR AVE. BRIDGE

made it necessary to use very long girders in the design, as it was desired to have no more frequent obstructions than between alternate pairs of tracks. The longest girder used was 113 ft. 4 7/16 in. long; several others were over 100 ft. long.

The sharp skew also introduced considerable difficulty in caring for the expansion and for lateral stresses due to wind. It was, of course, impracticable to use steel towers. Rocker bents would in some cases have had a length of 100 ft. between posts. No satisfactory design was found for a lateral system to be used with steel bents. The general nature of these difficulties will be apparent from an examination of the plan Fig. 1, and noting the relative positions of any two girders crossing the same set of two tracks.

In order to avoid the disadvantages of steel bents, it was decided to make each girder-support an independent pier; and, to allow a reasonable spacing of the adjacent tracks, all piers between tracks were made of reinforced concrete, only 18 in. thick in the body. To get the required strength to resist the bending moment resulting from wind and expansion forces, this thin portion of the piers was given considerable length, and was reinforced with deformed steel bars in both side faces. At the top and bottom the piers are widened out transversely, following the standard clearance diagram. The reinforcement is carried down only to the top of the footings, which allows the footing concrete to be poured before the reinforcing bars are placed and thus simplifies the work for the contractor. The neat work is stable upon the footing, for the applied forces, without the use of reinforcing bars at the joint. Typical details of the reinforced piers are shown in Fig. 3.

Having eliminated steel bents, no particular difficulty was found with the lateral system. The skew of the tracks is so great that girders crossing different sets of tracks lie nearly opposite each other. These could now be arranged to expand together, and were therefore joined by the same lateral system. Some of the floorbeams have one end connected to the fixed end of one girder, and the other end to the expansion end of another girder; but as the floorbeams are of considerable length and are connected to the girders by rather flexible gusset-plates, this construction introduced no complications. The lateral connections to such floorbeams were arranged to allow the necessary play, and the floor-plank fastenings were made such as to allow the floorbeam to move slightly under the planks. The floorbeam was thus left free to accommodate itself to the movements of the girders connected to it.

The bearings of the girders on the piers are designed as they would have been for ordinary masonry piers. Spans less than 100 ft. long rest with sliding bearings upon cast-iron bolsters, while spans over 100 ft. long have pin-bearing shoes, with segmental rollers under the expansion ends. No unusual care was taken to avoid moderate eccentricity of loading on the piers, as the skew is so great that only a small component of the eccentricity is really effective.

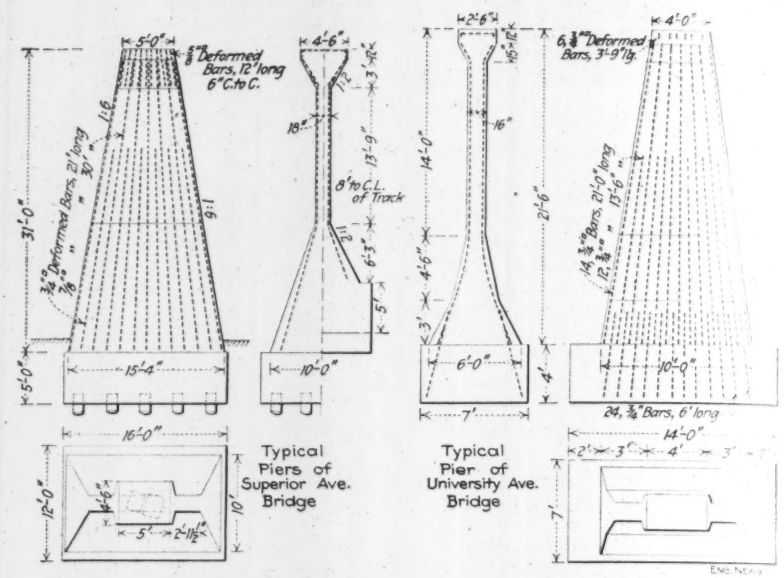

FIG. 3. REINFORCED-CONCRETE PIERS OF SUPERIOR AVE. AND UNIVERSITY AVE. BRIDGES.

At the west end of the bridge two short girders lie nearly opposite a long girder, and to avoid complication of the lateral system the two short girders were made to expand together. This was done by putting a common heavy sole-plate under the adjoining ends of the short girders, and supporting this plate upon a roller bearing. At the end of the short girder where the expansion of both short girders is cared for, only a sliding-plate bearing was used, as the frictional resistance is no greater there than at the end of an ordinary short girder, though the motion is greater than at any other sliding bear-

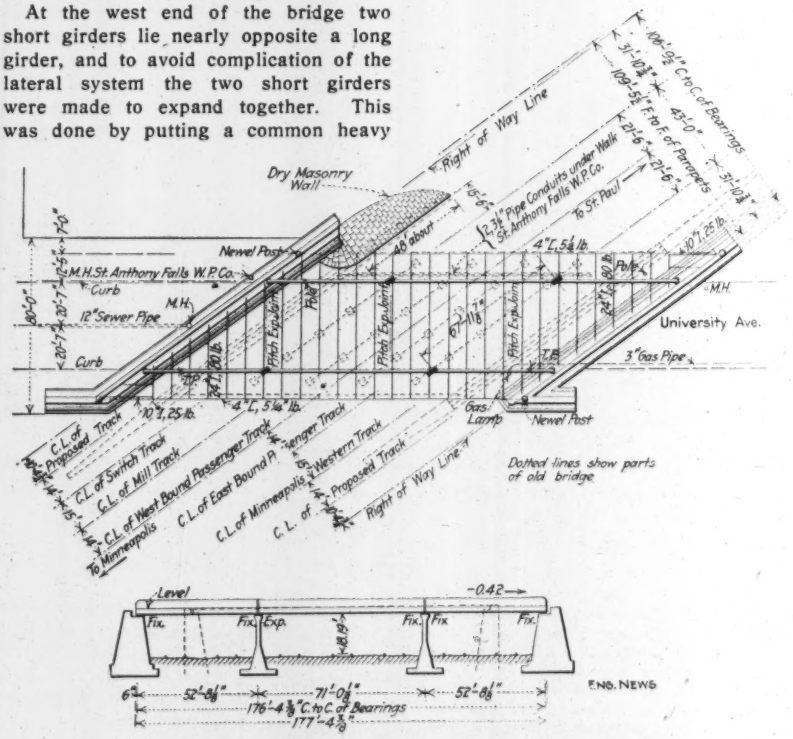

FIG. 4. PLAN AND ELEVATION OF UNIVERSITY AVE. BRIDGE

ing. With this arrangement the two short girders could be connected to the opposite long girder by a common lateral system.

The erection of the steel for this bridge was done with a derrick car operating on the permanent tracks under the bridge, and upon a special spur track switching is done under this bridge, and the freedom from obstructions which results from the elimination of all bracing is of considerable value. As shown on the plan, Fig. 4, there are only four piers about 3 ft. by 9 ft. 3 in. in size at the top of the tie, in an area of 11,000 sq.ft. covered by the bridge.

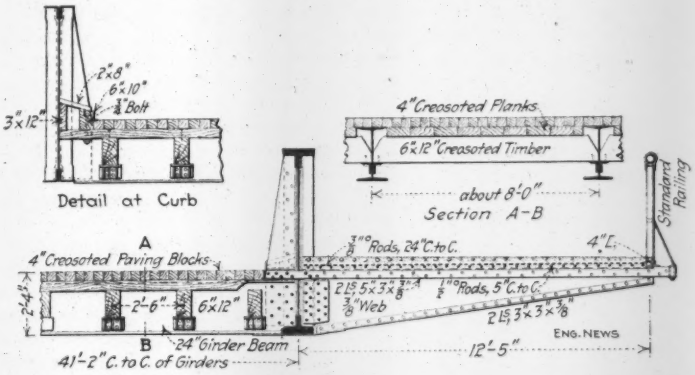

FIG. 5. SECTIONS SHOWING TIMBER FLOOR CONSTRUCTION, UNIVERSITY AVE. BRIDGE

laid along the center line of the bridge under the west end, where the permanent tracks were not yet laid. Although some of the girders were of unusual length, they were of light design, and were handled by the derrick car without difficulty.

In the construction of the roadway, pitch expansion joints were used along the curbs, and at intervals of about 45 ft. across the roadway. Expansion joints with steel plate covers were used in the sidewalk slabs.

The piers for this bridge were made only 16 in. thick (as against 18 in. at Superior Ave.) as the bending was not severe, and it was desired to obtain as much clearance as possible with tracks at 15-ft. c. to c. spacing. The footings were made narrow to allow of construction without interference with railway traffic. Short reinforcing rods were used to tie the neat work to the footings, getting a possible increase of stability without adding any great complication to the construction work. The pier construction is shown in Fig. 3.

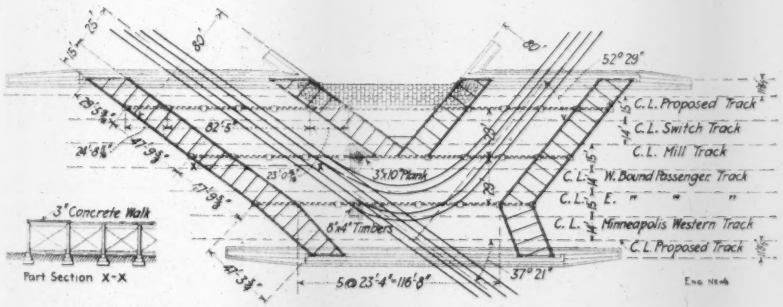

FIG. 6. PLAN OF DOUBLE BRIDGE AT FIFTEENTH AVE. AND FOURTH ST., MINNEAPOLIS

UNIVERSITY AVE. BRIDGE

The design of the reinforced-concrete piers of the Superior Ave. bridge proved so satisfactory that it was decided to use piers of a similar construction at the University Ave. crossing, although the conditions were such that skew steel bents could have been used. The steel bents, however, would have been very long, giving a bad angle for the diagonal braces. Furthermore, a good deal of

In the design of the superstructure the requirements were: a roadway 40 ft. wide, with 12-ft. walks along each side beyond the 40-ft. width, and very shallow deck construction to hold down the cost of lowering tracks to a minimum. These results were obtained, as shown in Fig. 5, by using 24-in. girder beams for floorbeams, and arranging the wooden stringers and planking in such manner that the top of the planking supporting the creosoted blocks is flush with the tops of the floorbeams. This design gives a depth of about 28 in. from top of roadway to clearance line. It worked out very well in construction.

The sidewalks were supported as shown in Fig. 5, by very shallow steel brackets made with solid webs. As the load on the brackets is considerable and the depth very small, the flange stresses could not be cared for by connection to stiffeners in the usual way. The bracket flanges were, therefore, connected directly to the flanges of the floorbeams, and the short floorbeams at the ends of the bridge were anchored at the masonry end to withstand uplift.

Some difficulty was experienced in the erection of the brackets, in getting the outer ends at exactly the proper elevation, so as to give a good appearance to the bridge railing. The connections to the girders are so shallow that a very slight error in the location of rivet holes would cause a very considerable error in the elevations of the outer ends. Where such shallow and long brackets are necessary, this difficulty could be overcome by requiring the rivet-holes to be reamed together in the shop, with the parts all placed in exactly the right relation. The difficulty could also be overcome in erection by shoring up the outer ends of the brackets to proper elevation before riveting.

The loading used in designing this bridge was: For the walks, 100 lbs. per sq.ft., without impact; for the roadway, a 24-ton road roller with 100 lb. per sq.ft. over the portion not covered by the roller, or 100 lb. per sq.ft. over the entire roadway, impact of 25% being added to all roadway loads. Wind was taken the same as at the Superior Ave. bridge.

FIFTEENTH AVE. AND FOURTH ST. BRIDGE

This bridge, as shown in Fig. 6, carries two intersecting streets over tracks passing diagonally underneath. Very shallow deck construction was required, as the streets could not be materially raised, and it was impossible to lower the tracks more than a very small amount on account of grade requirements. The arrangement of tracks and streets precluded the use of through girders.

The construction adopted consists of shallow girders at the curb line and outer sidewalk edge (Fig. 7) with lines of girders running from post to post between alternate tracks. The spaces between these various girders were spanned by a solid deck of creosoted timber, 14 in. thick. The maximum span for the timber is about 33 ft., the usual span is 29 ft.

The curb girders were made 22¼ in. deep back to back of flange angles, and the girders at the outer edge of sidewalk

24¼ in. deep. As the span of some of these girders is as great as 47 ft. 9⅝ in. they were made continuous over the posts (Fig. 8), with necessary field splices located at points of minimum moment. The deflection and vibration were reduced to a minimum in this way, without any corresponding disadvantages except the greater difficulty of calculation of stresses.

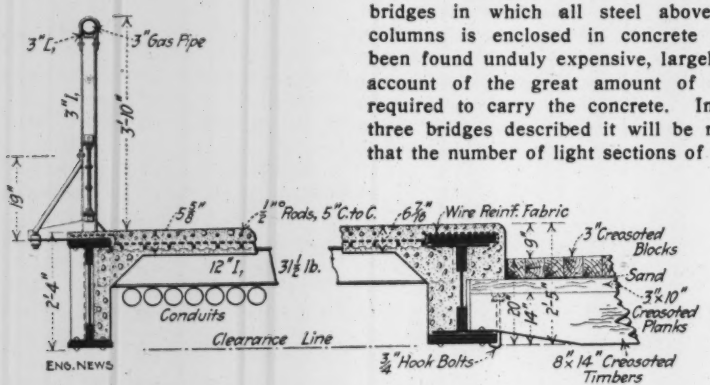

FIG. 7. PART CROSS-SECTION OF FIFTEENTH AVE. AND FOURTH ST. BRIDGE, AT RIGHT ANGLES TO FOURTH ST.

On the 14-in. timber deck, which rests on the steel girders, was placed a course of 3-in. creosoted planking, and this in turn carries 3-in. creosoted wood paving blocks. The rails for the four street-car tracks rest directly on the 14-in. timbers. Before creosoting, these heavier timbers were framed to proper length and cut to the proper angle to fit the girders. They were also grooved to clear rivet heads. For this purpose complete detail drawings were made of each stick. No attempt was made in this preliminary framing to clear the stiffeners of the girders. The necessary cuts for this purpose were made in the field, and the cuts painted with Avenarius carbolineum. The 3-in. planks were cut in the field to clear rails, etc., and the cuts painted.

The design loading for this bridge was the same as for the University Ave. bridge, with the addition that 42-ton street cars were provided for.

PROTECTION OF STEEL AGAINST CORROSION

The Great Northern Ry. has had the common experience that in bridges carrying streets over busy tracks the use of small unprotected I-beam stringers is very unsatisfactory on account of the rapid corrosion of the thin webs and flanges. On the other hand, bridges in which all steel above the columns is enclosed in concrete have been found unduly expensive, largely on account of the great amount of steel required to carry the concrete. In the three bridges described it will be noted that the number of light sections of steel is small, and that such sections are encased in concrete where they carry bending stress. Creosoted timber is used in place of light I-beams, and should have a very much longer life. In general, only steel of fairly heavy section is used. It is believed, from the life of the heavier sections in older bridges, that these heavy sections will last many years, and that the bridges will be more truly economical than if designed with fully protected steel parts. Of course, a large factor in this economy is the fact that the Great Northern has direct access to the low priced timber of the Pacific Coast states.

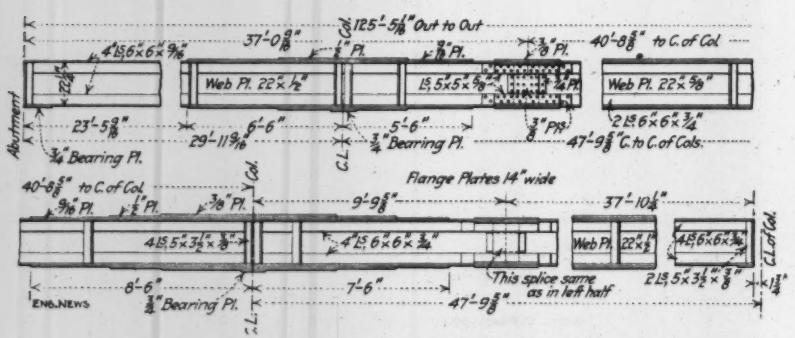

FIG. 8. ROADWAY GIRDER, CONTINUOUS OVER THREE SPANS

Increasing the Power Capacity of Locomotives*

BY W. F. M. GOSS†

The power developed by a steam locomotive is derived from the fuel it consumes. Other things being equal, the greater its rate of fuel consumption the greater will be its capacity. The locomotive is the hardest worked of all types of steam plants. The draft which urges its fire is unusually strong, under normal operating conditions ranging from 5 to 12 in. of water. This results in the burning of from 100 to 200 lb. of coal per foot of grate per hour, and a rate of evaporation which may exceed 16 lb. of water per foot of heating surface per hour.

The draft, the rate of combustion, and the rate of evaporation have been subject to little change during the last 25 years, but the demand for increase of power has been present throughout this period, and has been met by increasing the dimensions of the locomotive. The result is a complete steam-power plant which, as represented by a recent design, is capable of developing 1 hp. for each 121.4 lb. of weight.

The weight of the modern locomotive cannot be greatly exceeded except at the expense of extensive improvements in track or through the adoption of an arrangement of wheels which will permit the load to be much more widely distributed than at present. As it is not likely that the demand for higher power will cease, the problem of supplying it is one of more than academic significance. It presents two possible lines of solution: one through the better adaptation of fuel to the needs of locomotive service, and the other through the better adaptation of the locomotive to the requirements of the fuel which it has to burn.

DEVELOPMENT IN FUEL

Conditions of service which demand high power will justify unusual care in the selection of fuels. The coal used under such conditions should have a high thermal value, and it should be low in clinker and ash. It should be sized before it is put upon the tender and if necessary it should be washed and sized. If we consider that on the grate the combustion of coal can proceed only as air can pass through the bed and around the individual particles of coal, we will easily understand the superior advantages offered by the sized fuel. A special advantage of the briquetted fuel so much used in foreign railway practice is that the briquettes are of uniform size.

When the coal fired is made up of pieces of uniform size, it forms a bed on

*Abstract of a paper presented at the annual meeting of the International Railway Fuel Association, held at Chicago, May 22-25.

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the grate in which the interstices between the pieces of coal are uniform and the admission of air over the entire area of the grate is in finely divided and uniformly distributed streams. The result is that every part of the fire is maintained in a condition of maximum efficiency; the temperature of the firebox will be higher than when mixtures of lumps and fine coal are fired; the rate of combustion will be greater, and, as a consequence, the capacity of the locomotive will be increased.

The power of a locomotive cannot be increased indefinitely merely through the proper selection of fuel, but the limits of its maximum performance may be materially extended. A small locomotive may be made to perform the service of a larger one, a saturated steam locomotive may be made to perform the service of a superheating locomotive of the same class, and a large locomotive may have its power limit materially increased.

There are no objections to the general introduction of specially prepared fuel for locomotives except those of cost. But the ultimate cost, when measured in terms of service given, will be found in many cases justifiable. Railways in their desire for some increase in power, do not hesitate to increase the weight of their locomotives by giving them larger boilers, by raising their steam pressure, and by adopting compounding and superheating. All of these are expensive measures, but they have been justified in practice by the results obtained. A great opportunity is available for increased power of locomotives through the more careful selection of their fuels. The time is at hand when lump coal will be washed and sized, and fine coals will be washed and briquetted. These processes (except that of briquetting) are inexpensive, and a demand for their employment will soon be forthcoming from the railways.

Development in Design

The alternative plan whereby the power of the locomotive may be increased, is that which provides for a development of its design along lines which will give it greater capacity to consume the indifferent fuels which under present practice are commonly supplied. The first requisite is a large grate, and grate areas have increased enormously during the last 25 years; whereas the area used to be less than 20 sq.ft., now it is often more than 70 sq.ft.

If a design could now be made which would permit the present maximum grate area to be doubled, several important results would at once be secured. For example, when 6000 lb. of coal are burned per hour on a 60-ft. grate, the rate of combustion is 100 lb. per foot of grate per hour and the spark loss with many fuels represents fuel values which approach 10% of the coal fired. The collection of ash and clinker on the grate so much impedes the draft as to require a thorough cleaning of the fire after a run in passenger service of from 100 to 150 miles. A greater distance, if attempted, must generally be run at reduced power.

With a large grate these conditions are changed. The burning of 6000 lb. of coal on a 120-ft. grate would reduce the rate of combustion to 50 lb. per foot of grate per hour, and the spark loss to 2 or 3%; and would permit continuous operation for a passenger run of 300 miles between the cleaning of fires. It is true that the larger grate would be at some disadvantage from losses in the fuel left on the grate at the end of the run, and in the larger amount required to cover the grate in the process of starting fires; but these disadvantages would be neutralized by the possibility of increased mileage between the starting of new fires. With the larger grate, only half as many new fires would need to be made per 1000 miles run. While the same total amount of coal is burned in each case, it is evident that the 8% saving in spark losses would at once be made available as an 8% increase of power.

With the larger grate there is the possibility of increasing the rate of combustion. An increase in the total fuel consumed from 6000 to 8000 lb. an hour, would increase the power capacity of the locomotive by 33% and would involve rates of combustion which (judged by present-day standards in locomotive service) would be accounted low. If the rate of combustion were forced to 10,000 lb., the increase of power would be 66% and the rate per unit area of grate would still be below the maximum now common in locomotive service.

Suggested Design of Firebox

Locomotive grates having an area of 150 ft. or more would necessarily involve some new departures in locomotive design. As the width could not greatly exceed 7 ft.,* its length would need to be from 20 to 25 ft. This may mean a complete abandonment of the existing type of locomotive boiler, but it does not necessarily imply such a change. It does mean, however, the adoption of an articulated form of locomotive which will admit of a space of 25 ft. or more between the two systems of wheels. It should be possible either to increase the spacing of the frames over this space or to drop the frames so low that the firebox and boiler with attachments may have an unobstructed area the full width of the track clearance for all heights 3 or 4 ft. above the rails.

Automatic stoking must be provided for. This can best be done by having the stokers feed transversely across the boiler from both sides of the firebox. The stokers would be very short in the direction of the fuel movement, probably not more than 30 or 32 in., and they would discharge on a flat dump grate running the whole length from front to rear of the firebox. The aggregate width of the individual stokers on each side would, of course, be from 20 to 25 ft., but they would be split up into as many different units as would best provide for the construction of short arches over them.

By such an arrangement, the green coal would pass under the mud-ring of the boiler and under a short arch, where it would ignite. It would gradually be pushed forward toward the center of the firebox to the flat dump grate, where it would be met by fuel coming in from the other side. The inward movement of coal from both sides toward the center of the grate would, of course, proceed throughout the full length of the firebox. The fact that the ignition of the fuel would be under an arch would make the combustion nearly or quite smokeless, the mild draft would make the cinder losses small, while the low rate of combustion per unit area of grate, and the provisions for cleaning supplied by the stokers and dump grate, would permit continuous operation at full power for a very long period.

Narrow hoppers supplying these stokers would extend the whole length of the firebox on both sides, to the full width allowed by the track clearances. The operating mechanism of the stokers, which would be beneath them, would be allowed the same total width. An extension of these hoppers upward on both sides to the level of the top of the boiler or higher, would provide space for all the coal necessary for a run. No coal would be carried on the locomotive tender and none would need to be rehandled on the locomotive.

Difficulties would, of course, appear in the construction and maintenance of a stay-bolt firebox 25 ft. in length, but a demand for a firebox of such dimensions would doubtless call out various means for supplying it. There would be no difficulty in constructing a Jacobs-Shupert firebox of any desired length. The boiler would be so located on the frames that its back-end would be just in advance of the rear system of driving wheels, and a foot-plate carrying all of the auxiliary machinery of the locomotive would extend rearward over the axles of these rear wheels and perhaps over the wheels themselves.

If desired, an attempt could be made to design an entirely new form of boiler, such as a boiler of the water-tube type. But it is not likely that the adoption of any such new type would of itself simplify the general problem.

*The boilers of Mallet engines of the 0:8:8:0 class on the Baltimore & Ohio R.R. have fireboxes 9¼ ft. wide and 10½ ft. long, with 100 sq.ft. of grate surface. And in the new 2:10:2 engines of this Chicago, Burlington & Quincy R.R. the grate is 8x11 ft. But with a mechanical stoker on each side of the grate, as proposed by Dr. Goss, 7 ft. would be probably the maximum width practicable.—Editor.

Draft Arrangements on Locomotives*

By H. B. MacFarland†

The strong draft required for the rapid rate of fuel combustion in the locomotive firebox is created universally by utilizing the exhaust steam as a jet in the smokebox and smokestack to induce draft through the firebox and tubes. While this is effective it is wasteful of power, but, although other means of creating the draft have been tried (in order to allow of discharging the exhaust at lower pressure), none of these have been successful in practice and none have come into use. In this paper, the great loss of power in the engine due to the ordinary method of creating the draft by the exhaust jet is discussed from a general point of view, and particulars are given of extensive tests made to ascertain actual conditions on various classes of engines in service on a large railway system.

*Abstract of a paper read at the annual meeting of the International Railway Fuel Association, at Chicago, May 24.

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A careful study of engine performance, in order to obtain concrete information as to the maximum duty and capacity from different types of locomotives for different and widely varying conditions of service and operation, leads to the general conclusion that the modern locomotive is very inefficient in its transformation of the potential energy supplied in the fuel to kinetic energy transmitted to the drawbar. A study of tractive-effort diagrams shows that while the tractive power at starting and accelerating trains at low speeds is closely approached, yet at average working and at high speeds the tractive effort is altogether too low and is far below the ideal. The theoretical engine of highest efficiency must be supplied with energy at the very highest temperature and reject it at the lowest possible temperature. The boilers of modern locomotives have a comparatively high heat efficiency, varying from 50 to 85% where feed-water heaters and superheaters are employed. Only a small portion of this energy is changed into useful work. The maximum amount is rejected as a waste energy.

In order to raise the tractive-effort curve and to get higher locomotive efficiencies the boiler pressure has been raised from time to time until it is not uncommon to find engines, both simple and compound, operating above 200 lb. pressure. It is true that raising the pressure and temperature does tend toward higher efficiency, but a depression of pressure and temperature of the energy rejected gives a greater efficiency for the same change of temperature. The rate of change in temperature is low at the high pressures and high at the low pressures. Engine efficiency, therefore, is increased at a much greater rate by causing the heat to be rejected at a decreased pressure than by having the heat supplied at an increased pressure.

Valuable and efficient experimental work has been done in developing a standard "front end." However, on different railway systems and on different portions of the same system there is great diversity of opinion as to the arrangement of front-end apparatus. The idea of arranging the draft system for efficiency is seldom considered, or only as a secondary consideration. The principal object is to draft locomotives for good steaming.

Drafting a locomotive is accomplished at the loss of considerable energy. The front-end should be defined as an apparatus for doing work, receiving the energy from a source of power and delivering a portion thereof in the form of a specified result. The source of power is the exhaust steam from the cylinders and the useful work accomplished is represented by the volume of furnace gases which are delivered against the difference in pressure existing between the atmosphere and smokebox. In order that the power of the jet may be sufficient it is necessary that the engine of a locomotive should exhaust against a back pressure. This back pressure varies according to local conditions. The ratio of power in the exhaust to actual power required to draw the gases through the flues and exhaust into the atmosphere is very high. The back pressure tends to decrease the cylinder performance and thus decrease the available power of the locomotive. Designers have, accordingly, devoted their energies, so far as drafting is concerned, to securing the required draft action in return for the least possible back pressure. In other words, the effort has been to increase the ratio of draft to back pressure, which ratio has been defined as the efficiency of the front end.

The theory of the exhaust has been in existence for a long time, but it is not yet possible to determine in advance what will be the effect of a given arrangement (such as a blast pipe of a given shape placed at a given height). The experiments made have been mainly practical, the jet being tried under different conditions until it is thought that the best result is attained. Special experiments, which are interesting but not numerous, have been made in Germany by Mr. Von Borries and in this country by the American Railway Master Mechanics Association.

The main consideration of those charged with locomotive operation is to get the engine in such shape that it will steam freely and get its tonnage over the road with the least delay. But the theory of drafting by the exhaust jet is so uneconomical and productive of such great thermal losses and energy losses, due to back pressure on the cylinders, that any saving effected by minor adjustments within the smokebox would have but small bearing upon the total fuel cost. The simplest and most effective way to increase the draft and produce a good steaming engine is to reduce the size of the exhaust nozzle, either by a bushing or a bridge in the tip. But few realize the tremendous tax which such an arrangement is upon the effective power of the engine.

Historical

It is said that the exhaust steam was first discharged into the smoke-stack by Trevithick (1803), who did not realize its great value in producing draft, but adopted this as the most convenient way of disposing of the exhaust. It is still the only successful method of producing draft on locomotives, although experiments have been made with various other methods. In 1835, Seguin tried an induced-draft system, using a fan in the front end, but this failed through inability to secure a fan of sufficient capacity to handle the volume of gases. In 1837, the Liverpool & Manchester Ry. used a steam jet instead of the exhaust, but while effective it was so wasteful as to be prohibitive. The steam jet has often been tried, however, and is today used in the form of a blower to supplement the exhaust blast at times when the engine is not steaming properly, and to create a draft when the locomotive is not running.

The power dissipated in creating draft by the exhaust steam was early recognized to be enormous, and it was stated in an article on "Combustion and Fuel Economy," as early as 1855, by A. L. Holley (speaking of American locomotive practice), that the power expended in blowing the fire with the exhaust steam amounted to more than 200 hp. in the moderate sized locomotive then in use. The value of a variable draft on the fire was early recognized, in order that the fuel burned could be controlled and economy secured by a reduction in back pressure on the engine when the boiler was making steam freely. The utility of a variable-exhaust nozzle controlling the draft is practically acknowledged by the great number of experiments in this direction. But despite the many advan-

tages, this apparatus has never become popular in America, owing to the difficulty in securing a variable exhaust that would always operate without sticking or otherwise getting out of order, and to the difficulty of practically educating enginemen to its intelligent use.

About 1865 the Hudson River line made some notable experiments in an effort to secure a variable draft without the use of a variable exhaust nozzle. A movable chimney was raised or lowered in the smokebox, increasing the draft when it was lowered and decreasing the draft when it was raised. This eventually developed into the petticoat pipe, now used so extensively on American locomotives, and which is held in a stationary position, serving to equalize the draft between the upper and lower tubes.

The diaphragm plate was first used to prevent the front end from banking up with coals; it was found that when this plate was introduced the draft was more evenly distributed over the top and bottom flues. Adjustable slides were later applied and the diaphragm plate made to equalize the draft better than the petticoat pipe. This plan was patented by Mr. Hudson and generally used in the Rogers locomotives. The diaphragm plate further served to make locomotives self-cleaning in the front ends. Netting was introduced in the front ends soon after the diaphragm plate, and served to retard the escape of the largest cinders and sparks and break up a large proportion of the finer sparks.

General Arrangement

No definite rule has been established as to the best proportions of smokebox, stack and exhaust pipe. Prof. Goss, as a result of his exhaustive laboratory experiments on a locomotive, has given definite and valuable recommendations, but they have not been generally adopted by American designers and builders. It is generally agreed that the dimensions of the exhaust nozzle and stack, as well as the position of the former, may be computed from certain formulas, but the results must be corroborated by practical experiments with each different class of locomotives. Practice is the only safe criterion.

Considerable experimental work has been done in America with double exhaust pipes, and although successful in some small degree it has been found that a single exhaust in the center of the chimney is scarcely inferior to a double exhaust. In 1896 the Toledo, Peoria & Western Ry. used a locomotive with two stacks side by side. There was no division in the smokebox, but the exhaust pipe was double and of such a form as to lead the exhaust from each cylinder into separate stacks. It was claimed for this arrangement that it gave a more even draft through all the tubes, permitted an increased size of exhaust nozzles and saved boiler wear and fuel, but the design never came into extended use.

The details of smokebox arrangement vary greatly in different countries. In America the exhaust nozzles are placed low, and petticoat pipes and diaphragm plates are used to equalize the draft. In England and on the Continent the nozzle is placed as high as the top row of flues or higher, extending sometimes even into the stack. In America efforts are made to make locomotives self-cleaning in the front end, but on the Continent smokeboxes are designed of sufficient length to collect the cinders and sparks for removal at end of run. Deflector plates have been in use in America and on most European roads for many years, but are still rejected by the German roads, as results of their experiments have shown that the deflector plates interfered with the movement of the gases in the smokebox and necessitated a sharper draft. Claims are made that the deflector plate induces the draft through the lower flues, which otherwise have a tendency to become choked. The flames are more evenly distributed through the tubes and the fire is more clearly and uniformly burned. With the deflector plate the accumulation of cinders in the front end is prevented and small particles of coal are more completely burned up in the firebox.

The exhaust pipes generally are of a constant cylindrical section up to near the exhaust tip, where they have the form of converging cone. With inside cylinders the pipe is simple and straight. Where there are outside cylinders the pipes usually have sudden bends to where they join, which has the effect of spreading the exhaust but causing resistance to the flow of steam. With fixed exhaust nozzle the cross-sectional area and shape are determined by experiment and former practice. The annular shape of the nozzle is generally supposed to give a better draft than a circular orifice of the same area.

Considerable use is made of the variable exhaust on the Continent, although quite a wide diversity of opinion exists relative to its value, and many of the leading roads use nothing but a fixed exhaust. The most usual form of variable exhaust nozzle is two flap valves, each with a spindle. Considering trouble in adjustment arises from the fact that the flap valves must be firmly fixed on their spindles and at the same time be easily removable, as the exhaust pipe rapidly becomes choked. This form of nozzle is used on the French Northern Ry. The Belgian State Ry. uses a cylindrical exhaust pipe, which terminates in a cone. A sleeve is fitted in the cylindrical part which, when raised into the conical part of the pipe, reduces the area of the nozzle. One form of variable exhaust pipe has a hinged top which, when raised, gives a larger exhaust opening. The French Western Ry. uses a vortex which distributes more uniformly the gas through the tubes, but such nozzles choke up rapidly and irregularly, which prevents their working properly and also increases the back pressure.

American railway practice has shown negative value in the use of bridges in the exhaust, but German practice has shown this to be a simple and effective way to improve the draft, and it is generally adapted on German and Belgian roads.

Tests on the Atchison, Topeka & Santa Fe Ry.

In order to determine the relative efficiency of the front-end drafting arrangement of the principal classes of locomotives (both passenger and freight) in use on the Santa Fé System, a number of tests were made and complete data bearing on the subject secured. The efficiency of the front end has been commonly defined as the ratio of draft in inches of water per pound of back pressure in the cylinders. Although a few scientific investigations have been made relative to the subject of locomotive drafting, an exhaustive study of the subject of back pressure in the cylinders produced by creating draft with the exhaust jet has been generally neglected.

A study of the general arrangement in the front ends of the numerous locomotives operating on the Santa Fé shows but two general classes predominating: one for coal burning, and the modification of such arrangement for oil-burning locomotives. A closer analysis of the drafting arrangements shows a wide variation in the minor details of adjustment, such as position of petticoat pipe or diaphragm plate. It shows also that the arrangements in use do not follow closely the recommendations laid down by Dr. Goss as a result of scientific study and tests, and which recommendations were endorsed by the American Railway Master Mechanics' Association. This analysis revealed the individuality of the different foremen, yet it may be stated that the arrangement of front-end apparatus will not be the same for all engines of a similar class even on one division.

There is a general impression that some power is lost on account of back pressure, and the investigations show the price which a locomotive pays in fuel and power for drafting with the exhaust jet. They show that the potential energy lost is considerable in amount and also in percentage of the total power of the locomotive. The ratio of potential power thus absorbed to the actual tractive power is on an average 1 to 0.66. This loss increases directly with the speed, so that at high speed the capacity of the engine is greatly reduced and its curve of tractive effort is far below the normal.

The back pressure, due to any given sized nozzle, was found to be practically

the same in the cylinders of a compound locomotive as a simple locomotive. But the power loss is much greater for the compound, due to the greater area of the low-pressure piston. As back pressure acts against the piston, it can be computed as actual horsepower developed but not utilized. When thus computed, it is found to range from 10% of the total available power of the engine at low speeds to over 50% at high speeds. This holds true with both ordinary freight and passenger engines, but for Mallet engines the losses are much greater. The wide variation in drafts and exhaust pressures is shown by the summary in Table I, and must be attributed to conditions of operation, grades and other purely local circumstances.

The curves plotted from the observations show that the back pressure remains practically constant at all speeds, indicating that the back pressure depends upon the volume of steam passing through the exhaust nozzle regardless of the speed of the locomotive. The draft, then, is dependent upon the intensity and velocity of the exhaust jet and not on the speed. Any increase in volume of steam passing through the exhaust nozzle in a unit of time increases the intensity and velocity of the exhaust jet and causes a corresponding increase in draft.

Since the back pressure remains practically constant for any increase in speed, it necessarily follows that the back-pressure horsepower is the only variant and must increase in direct ratio to the speed. This statement is borne out by the tests. The back-pressure horsepower curve, then, is a straight line, the law being established by each individual chart, and a formula may be developed for each class of locomotive which would enable one to compute the back-pressure horsepower for any given speed in miles per hour.

While it is generally known that the drafting of locomotives under present practice is accomplished at considerable loss in power, the magnitude of this loss is little realized. Calculation of the theoretical horsepower required to draw the gases through the flues and front end of a locomotive is comparatively simple, and for a given engine it is found that the power required to draw the gases through the tubes alone will be 20.8 hp., while that required to draw them through the tubes, under the diaphragm and through the netting will be 27.43 hp. The actual power utilized in producing draft in any given class of engines is taken as that due to the back pressure in the cylinders, which was obtained from engines in actual service. This back-pressure horsepower is not chargeable entirely to the production of draft, because of the impossibility of operating noncondensing engines without at least 3 to 4 lb. of back pressure, but the greater part of this power is expended for draft alone.

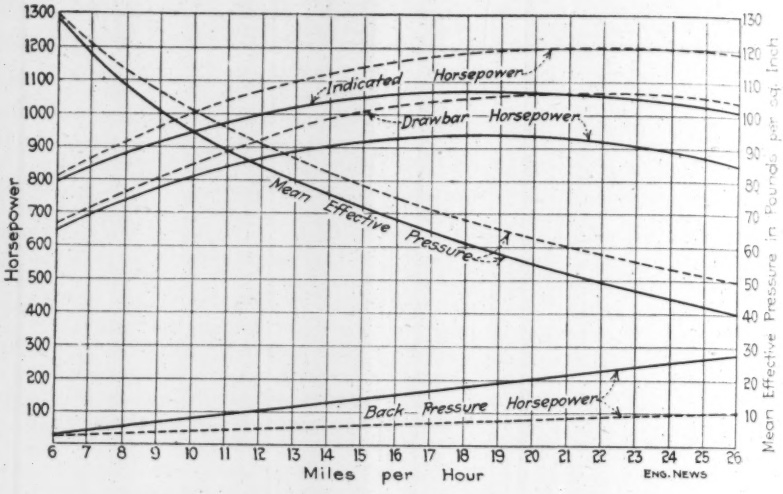

DIAGRAM OF HORSEPOWER OF LOCOMOTIVE WITH NORMAL BACK-PRESSURE DUE TO EXHAUST JET AND WITH BACK-PRESSURE ASSUMED TO BE REDUCED TO 4 LB. BY SPECIAL DRAFT APPLIANCES

The relation of power expended in producing draft to the theoretical power required to draw gases through the tubes and front end is shown in Table II.

This table is calculated from data secured in road tests of representative locomotives, including both passenger and freight, simple and compound, and coal- and oil-burning engines. The difference between the power required to draw the exhaust gases through the boiler and the power of the steam jet at various speeds, gives the excess in power directly chargeable to the exhaust jet. In the last column the values for this excess power consumed are given in percentage of actual work done. It will be seen that the efficiency of the steam jet, as a means of producing draft in a locomotive boiler, is extremely low from a power standpoint. The efficiency, based upon a mechanical standpoint (that is, the simplicity and reliability of this form of apparatus) is not included in this statement. It will be seen from the figures that the loss in horsepower due to

TABLE I. SUMMARY OF TESTS OF DRAFT, EXHAUST AND BACK PRESSURE ON LOCOMOTIVES: A., T. & S. F. RY.

Engine	Draft, ins.			Exhaust press. lb.			Back pressure h.p. at various speeds		
Passenger	Max.	Min.	Av.	Max.	Min.	Av.	20 m.p.h.	40 m.p.h.	50 m.p.h
4:6:2 simple	11.0	7.0	9.7	16.0	8.5	12.6	185	295	350
" "	12.0	6.0	8.6	22.0	9.5	14.7	175	285	340
" bal. comp	14.0	5.5	9.3	19.5	6.5	11.4	140	440	590
" simple	12.0	6.5	9.1	13.5	7.0	10.0	130	270	340
" "	13.0	9.0	11.5	21.0	10.0	16.2	155	345	
4:4:2 bal. comp	14.0	8.0	11.6	14.5	7.0	9.2	75	235	315
" "	7.0	5.0	5.8	13.5	8.0	10.2	115	255	325
Freight							15 m.p.h.	20 m.p.h.	25 m.p.h.
2:10:2 tan. comp	12.0	4.0	7.7	17.0	5.0	10.8	280	430	580
2-8:0 tan. comp	9.0	6.0	7.2	16.0	10.5	12.5	225	300	375
2:8:0 simple	14.5	7.0	10.8	15.0	5.0	11.2	130	195	260
2:6:2 bal. comp	7.0	4.5	5.5	10.0	4.5	7.3	105	145	185
2:10:2 simple	14.0	9.0	10.6	16.5	10.5	13.5	210	300	390
2:6:2 Vau. comp	10.0	6.0	7.9	16.5	7.0	11.7	170	210	250
2:10:10:2 Mallet	14.0	5.0	10.3	23.0	6.0	16.5	550	800	1050
2:8:8:0 "	24.0	11.0	15.9	22.0	8.0	14.4	490	745	1000
2:6:6:2 "	18.0	10.0	14.3	16.0	6.0	12.1	310	450	590

TABLE II. RELATION BETWEEN POWER REQUIRED TO DRAW THE GASES THROUGH THE TUBES AND HEAT EXPENDED IN THE DRAFT

Engine	Power required to draw gases through boiler h.p.	Back pressure at various speeds m.p.h.	Back pressure at various speeds h.p.	Excess power in steam jet h.p.	Excess power in steam jet per cent
No. 923; 2:10:2 tand.-comp	28	10	160	132	471
	28	15	275	247	882
	28	20	390	362	1,294
	28	25	500	572	2,041
No. 917; 2:10:2 tand.-comp	25	10	150	125	500
	25	15	300	275	1,100
	25	20	450	425	1,700
	25	25	600	575	2,300
No. 1700; 2:8:8:2 Mallet, comp	65	10	290	225	346
	65	15	385	320	493
	65	20	480	415	639
	65	25	575	510	784
No. 1301	25	20	300	275	1,100
	25	30	500	475	1,900
	25	35	600	575	2,300

the throttling of the engine exhaust is somewhat startling, amounting in many cases to several hundred horsepower.

If other means could be provided to draw the necessary volume of gases through the boiler for the same rate of combustion possible with a steam jet, at an expenditure of power somewhere near the calculated power required to draw the gases through the boiler, a tremendous saving in power would be accomplished. The power thus saved could be utilized in useful work, either as increase in speed or as a direct saving in fuel.

Charts have been prepared illustrating the possibilities of increasing the power by decreasing the back pressure in the cylinders to 4 lb. per sq.in., this value being selected as representing conditions that could be obtained if the steam was exhausted from the cylinders through an unobstructed opening. With such an arrangement, of course, it would be necessary to provide some other method of creating a draft. The accompanying cut is a chart showing the relation between back-pressure horsepower, indicated horsepower, and drawbar horsepower. The full lines are from actual tests; the dotted lines are assuming an exhaust pressure of 4 lb., and indicate the gain in power by such reduction of exhaust pressure. This particular chart is for a 2:8:2 simple engine, using coal, and as it shows very favorable conditions of operation the actual gain is relatively low. In charts of other engines larger possibilities are indicated.

The argument is often advanced that it is not economical to run locomotives at high speeds on account of the great back pressure and the loss in efficiency. This is a very pertinent argument in view of the facts. In service it is shown conclusively that the maximum power is obtained at speeds less than those desired for present time schedules. With increase in speed there is a proportional loss in horsepower due to back pressure. The result is that at some speed a locomotive will have its highest efficiency and that speed is generally lower than the speed at which the locomotive is required to do maximum duty.

Conclusions

In conclusion it may be stated that locomotive drafting as now practiced is objectionable for the following reasons:

1. It necessitates repeated experiments to secure a free steaming engine.

2. It increases liability of delay owing to the impossibility of adjusting appliances in the smokebox so that the engine will steam freely with all grades of fuel.

3. It results in a decrease of the power of the engine as speed increases, so that the hauling capacity and speed in fast-freight and passenger service are greatly reduced and restricted.

4. It necessitates the frequent double-heading of passenger trains owing to the depression in power as speed increases.

5. It is extravagant in the waste of water. This item is of great importance in districts where it is necessary to haul water for considerable distances.

6. It reduces both passenger and freight hauling capacity per unit of power.

7. It is enormously extravagant in the waste of fuel.

Fuel Economy on Railways

The fuel consumption of the entire American railway system reaches an enormous total, the annual cost being estimated at $240,000,000, so that economy in fuel consumption offers a promising field for a reduction in railway-operating expenses. An interesting paper presented at the annual meeting of the International Railway Fuel Association (held at Chicago on May 22 to 25) gave some enlightening information and suggestions in this direction. The paper in question was on "The Proper Method of Firing Locomotives," by D. C. Buell,* and while it related mainly to this specific subject it discussed other aspects of the problem of fuel economy. It is this latter feature of the paper which is of most interest to the mechanical engineer and the railway official. Mr. Buell remarked that those who are fighting for fuel economy usually center their attacks on the locomotive fireman, and are apt to lose sight of fundamental matters which are beyond his control and cannot be remedied by him. It is quite obvious that the proper training of the fireman is but one step (and perhaps not the most important step) in the solution of the problem.

The same general views were expressed by Robert Quayle† in an address at the same meeting, but he pointed out further that fuel economy depends as much upon the engineman as upon the fireman, and the same view was expressed in the discussion. For example, a man who habitually reduces the speed of a heavy train too soon in approaching a yard, and drags the train for a few miles, alternately working hard and applying the brakes, is responsible for considerable waste of fuel. Considering the locomotive as a power plant, Mr. Quayle declared emphatically that it is both efficient and economical when the work done and the power developed are taken into account.

It was stated in the paper that the ideal condition which is aimed at is to turn a maximum of the heat units in the coal into work at the drawbar, at the least cost and with 100% of service. It is understood, of course, that the heat unit and not the weight is the measure of fuel value, and due allowance must be made for difference in qualities of coal. A boiler efficiency of 100% may not be 100% drawbar pull efficiency if packing rings are blowing, valves are improperly set, or the machinery has excessive friction. And 100% efficiency of a fireman may not be 100% fuel efficiency, owing to high costs at coaling stations, improperly designed engines and carelessness in handling engines at terminals. High boiler efficiency may be misdirected fuel economy if the fuel is not burned so as to produce the maximum steam required for the service at the proper time. A really effective plan to attack the solution of the general problem of fuel economy must include the following features:

1. Determination and purchase of the grade and quality of coal best adapted to the requirements of the service. This is a matter for the purchasing agent or fuel agent, in coöperation with the engineer of tests.

2. Inspection to insure that the class of coal contracted for is actually delivered.

3. Economical distribution of coal to the various coaling stations.

4. Economical delivery of coal from the coaling stations to the locomotives.

5. Economy in fuel while the engine is in the hands of the motive-power department, from the end of one trip until the engine is again delivered to the operating department for another trip.

6. The boiler plant must be in condition to burn the fuel economically.

7. The engine must be in condition to get the maximum efficiency out of the steam delivered to it.

8. There must be a thorough and reliable accounting for the fuel delivered and used.

9. Correct and significant statistics must be furnished to those responsible for the use of fuel, in order to provide a check upon the results.

10. To insure proper results there must be a thorough and hearty coöperation among all concerned, including the engineman and fireman.

11. The fuel must be fired properly so as to obtain complete combustion, to furnish steam as required and to avoid waste. To which we may add that the engine must be so handled as to use the steam (and fuel) efficiently and economically.

Mr. Buell states that on some railways all these items are receiving careful attention, and probably on every road one or more of the items is closely watched. The object in calling attention to this matter has been to defend those who are daily striving against staggering odds to get their firemen to fire locomotives properly. The reason that road foremen, master mechanics, fuel experts or combustion experts have not been able to

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get permanent results has been in most cases in the overwhelming odds they had to work against. We give below the ideas expressed in the paper in regard to these several heads.

1. SELECTION AND PURCHASE — On most roads the officials have recognized the importance of a knowledge not only of the heat-value of the different grades of fuel available, but also of the ash content and the coking or caking properties, etc. Another factor to be considered is whether it is more economical to use mine-run coal or the higher-priced screened coal. The traffic and operating departments must be consulted to make sure that the interests of the company may be served well in the selection of the fuel. The dependability of the mine in working steadily and turning out a uniform grade of fuel is also a factor. After the proper grades have been determined they should be used regularly, so that engines can be properly designed and drafted to burn the fuel economically; and so that the men can familiarize themselves with the proper handling of the class of fuel furnished.

2. INSPECTION—Proper inspection of coal at the mines is as essential as the inspection of locomotives or cars. It should be made for both quality and weight.

3. DISTRIBUTION—The economic distribution of the fuel from the mine to the point where used is one of the big items of fuel economy. On roads where this matter is not carefully handled, as much money is wasted through this channel as by improper firing. It is an operating matter, and deserves a most careful study. In this connection the direction of the volume of traffic must be considered, so that the company coal can tend to balance the tonnage instead of throwing it further out of balance. Other factors are the reduction of mileage of empty coal cars, the tonnage that can be hauled over ruling grades, etc.

As an example, it has been found economical on one of the transcontinental lines to haul a large quantity of company coal from Western mines to Eastern terminals, and store it there for a time. The reason is that at certain seasons the traffic is almost entirely westbound. Then coal cars are needed east. These cars can be loaded at the mines, hauled east by power that otherwise would run light; the coal can be unloaded and stored and the cars released where wanted; all at an expense that is negligible compared to what it would cost to keep those Eastern terminals supplied at a later season when the traffic was nearly balanced or heavier eastbound.

4. COALING STATIONS—There is an astonishing variation in the cost of coaling locomotives, which may vary from 2 or 3c. per ton at a modern station, to 25 or 30c. per ton at some more primitive plant. One railway arranged with a company that makes a specialty of erecting coaling stations to finance the erection of a number of stations on its line. In a short time it saved enough on the cost of coaling engines to pay both the principal and interest on the investment. It is safe to say that a master mechanic or road foreman could save more money, save it more quickly and make the saving permanent, by reducing the cost of coaling engines than by a campaign among his firemen.

5. FUEL CONSUMPTION WHEN OFF THE ROAD—It is ridiculous to talk fuel economy to a fireman, when men are allowed to bring engines in from a trip with a ton or more too much of unburned fuel in the firebox (practically all of which is wasted when the fire is cleaned); and when, at this same terminal, hundreds of pounds more fuel are wasted in rekindling fires or in keeping fires in engines that are allowed to blow off steam around the yard or in the roundhouse. Such little economies (where they are economies) as the kindling of fires with oil and shavings, make the fireman realize that coal is a valuable commodity, and set him thinking about how he can save some.

6. CONDITION OF BOILER—There is nothing more discouraging to a good fireman than an engine that will not steam properly. But a poor steamer seems to have some hypnotic effect on a poor fireman or a new man that not only causes him to forget everything he has ever heard or known about the correct principles of locomotive firing, but suggests that he is no longer a fireman, merely a coal-heaver; and he acts on that suggestion. The average man, overtaken by the feeling that he has a good excuse for making a failure, fails with ease. The man to heed fuel economy talk is one who knows that the boiler plant of his locomotive is in good condition.

7. CONDITION OF ENGINE—The fireman of today is not stupid or weak-minded enough to listen with attention to either orders or pleadings about economical firing when the engine he fires wastes more steam than he wastes coal. This does not mean that two wrongs make one right; but human nature is a good deal the same the world over. The waste of steam mentioned includes not only the steam at piston and valve glands, packing rings, valve rings or seats, etc., but also that due to poor valve setting, excessive engine friction, etc.

8. ACCOUNTING—The accounting for fuel on most roads is a joke. There are few connected with the motive-power department of a railway who do not know of the pencil adjustments made every month at each coal chute to balance the tons of fuel charged against that point. This adjustment has become such a commonplace affair, that the enginemen and firemen know of it. How can we command their respect if we talk about proper firing of an engine to produce fuel economy, when they know that we cannot come within 50 to 300 tons per month of balancing our fuel accounts at different coaling stations?

9. STATISTICS—What statistics have we to prove whether or not a fireman is firing economically? Our ideal is maximum work at the drawbar with a minimum number of heat units. Our performance sheets at the best show only inconclusive comparisons. Pounds of coal per thousand ton miles on a level division and on a division with 2% grades are totally different propositions; and even comparing the same class of engines on the same run we fail miserably, because we have no accurate method of checking the amount of coal issued to an engine, nor of knowing the amount left on the tank at the end of the run. Neither do we credit the fireman with the coal consumed while the engine is at the terminal.

10. CO-OPERATION—The need of co-operation goes without saying. All departments are interested, and success cannot be attained (owing to the complexity of the problem) without the coöperation of all.

FIRING OF LOCOMOTIVES

The proper method of firing a locomotive is the logical method for all firemen to follow; for the simple reason that it is the easiest, the least laborious, and most satisfactory method known. There are fewer scoops of coal to be handled, little or no necessity for using the rake or slicebar, or of cleaning the fire; and the shaking of the grates is reduced to a minimum. In addition, the engine steams properly, unless there is something radically wrong with the engine, or the coal is devoid of heat units. But even in such a case proper firing produces the most steam possible under the conditions; and the fireman may safely feel that no one could have done better under the circumstances.

Aside from the firing, a large amount of coal may be wasted; the fireman may not keep the deck of the engine clean, he may throw away large lumps of coal instead of breaking them up, or shovel slack coal out of the gangway without attempting to burn it. At coaling stations, some coal is wasted by overfilling the tender, and the jolting on the run may throw off this excess coal. Another waste is due to the excessive use of the blower. Still another loss is due to not burning down the fire when coming into a terminal so as to prevent excessive waste of fuel when the fire is cleaned. Each scoopful of coal wasted represents nearly 2c. wasted or burned up unnecessarily.

It is an easy matter to tell how to properly fire a locomotive, but the problem of getting firemen to fire that way is a totally different matter. Conditions should be such that those responsible for the

use of fuel can conscientiously talk to and instruct the fireman about the proper method of firing, and insist on his firing properly; and then check him up to see that he does it.

There are only three ways by which firemen can be brought to a realization of the importance of the subject, so as to actually fire their engines properly, even when not under the eye of someone in authority. The first is by personal instruction and demonstration on the deck of the engine during a trip. The second is a combination of instruction by lectures, or otherwise, at the terminal and an accurate check of performance by an observer on the engine. Both methods are comparatively expensive, and both require considerable time in which to accomplish any appreciable results.

The third method is by offering premiums or bonuses to enginemen and firemen for economy in the use of fuel. This, however, is as a rule unsatisfactory on account of the lack of a proper system of accurately checking the results. The plan in practice seldom is fair and this causes dissatisfaction. With respect to other methods, these accomplish only the minimum in the way of results. Their only recommendation is that they keep the subject alive and that in some cases they are so economical that if they do any good at all they more than pay for themselves. In this latter category are combustion lectures, circulars and bulletins, instruction books, etc.

Strain Measurements of Brick Pavements*

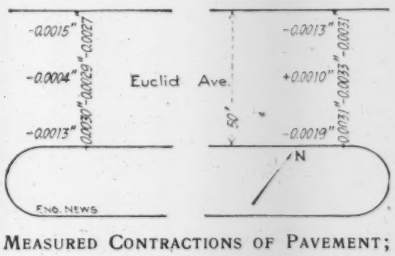
By James E. Howard†

The Bureau of Standards, in the performance of its regular functions pertaining to investigative tests of structural materials, has inaugurated tests on paving brick in place in the pavements. Laboratory tests on the properties of brick have been carefully made many times and in many places, the results of which are familiar to all. The present tests are intended to extend information to the behavior of the brick as found under service conditions, measuring the strains which are developed in the pavements themselves and from the deformations judging of the stresses or loads which are involved.

Conditions in a pavement are complicated, and in approaching the subject it is essential to ascertain the elementary features and so shape the work that one after another may be investigated.

Some preliminary work was done a year ago at Indianapolis. It has since been extended at Cleveland. The work in these cities has been directed toward acquiring data upon (1) the relations of the street-car tracks to the pavement, and (2) the effects of variations in temperature in stressing the pavement. These questions are quite distinct from those which relate to the supporting capacity of pavements against heavy wheel loads, or durability in the matter of wear or surface abrasion. So many streets furnish successful examples of pavements which have carried heavy traffic for a term of years that it was not thought necessary to include such observations at this time.

Preliminary to making strain measurements, a few sets of holes were drilled in the bricks, into each of which was dropped a little neat-cement mortar and a brass pin pushed into place with its top some 3/8 in. below the surface of the pavement. The two holes of each set were spaced 20 in. apart and the pins were carefully reamed to receive the points of the measuring instruments. To preserve these reference marks against the effects of traffic it was found sufficient to insert a small disk of blotting paper and then fill up the hole with putty flush with the pavement. In some cases it was advisable to color the putty so as not to arouse the inquisitiveness of the younger generation.



Measured Contractions of Pavement; Cleveland, Ohio

(Due to a temperature drop of 66° F.; transverse and longitudinal contractions on a 20-in. gaged length; one length showed extension.)

Before each measurement the pavement around the pins was brushed and blown clean, the putty plug removed and the pins wiped out.

Relations of Street-car Tracks to Pavements—These tests consisted of measuring the elastic depression of the track under the weights of cars and acquiring information on its influence on the adjacent pavement. The elastic depressions of the rails were measured on different types of track, selecting, among the number, places where maximum rigidity was likely to prevail.

The deflection meter was a stiff 4-ft. reach rod with a fixed pointed stem at right angles to one end, a micrometer-screw point at the other and a sensitive level bubble between. The depression observations were all made and completed on one occasion. The fixed end of the leveling rod was temporarily supported on a small surface plate, placed in the pavement; the top of this was leveled by previous adjustment for the purpose of accommodating any slight movement at the fixed end.

Readings would be taken before a car approached and then with a car as close to the reference points as it was possible to run and still use the deflection meter. The measurements did not interfere with traffic because of the short time required for a reading. Those made between a surface-plate and some point on the rail showed the deflection of the track; those made between two plates showed effects on the pavement.

In general, it was found that the difference in level of the rails between a loaded and an unloaded state is greater than can be followed by a monolithic pavement without the formation of cracks alongside the track. Occasionally track in the very best condition may not display excessive depression, but the uncertainty of maintaining such a state renders it hazardous to make a bond between the pavement and the track.

There is, in addition, a bodily settlement of the track resulting from insufficient support of the roadbed. This involves a permanent depression altogether too great to consider in connection with those lesser movements described. Bodily settlement, however, is a feature which cannot be left unmentioned. Some cases are so flagrant that a good pavement can hardly be made use of, by reason of the track ruts.

In these tests, the presence of a trolley car could be detected by the depression caused in the pavement even at 10 ft. from the track toward the sidewalk. Readings were secured on a tar-filled and a cement-filled pavement. At the intersection of two streets, with no trolley tracks, the depression caused by the weight of a man was detected at a distance of 12 ft. This observation was made at a place where the hollow rumbling sounds of passing vehicles indicated the pavement did not rest upon its sand cushion or foundation. It was noticed that the pavement at the crown of the street responded more promptly to a load coming from the side rather than along the center line of the street.

Pavements are elastic, as the properties of the individual brick and the cement filler would indicate. But the amount of transverse bending which a brick or a cement grouted pavement will endure without cracking is very limited, particularly when the material is in tension. A wider elastic range prevails for compression loads, substantially in the ratio of the compressive to the tensile strengths, or from ten to one or more.

Temperature Effects—Gaged lengths of 20 in. each were established in the pavement, in number exceeding 300. The

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reference points were set as already noted. The gaged lengths were located at the sides and middle of the street, in both crosswise and longitudinal directions. It has been found feasible to measure these lengths with an accuracy, commonly, to the nearest 0.0001 in. In this manner thermal changes may be followed very closely. During the time in which these strain measurements were in progress a range of pavement temperatures of 66° F. has been experienced. The accompanying figure shows some of the results which have been obtained on Euclid Ave., Cleveland, on a section of pavement just east of University Circle.

In general the expansions or contractions of the crosswise gaged lengths proceeded with greater regularity than the longitudinal movements. Modifying conditions influenced the longitudinal movements and a drop in temperature yielded results which showed normal contraction on some gaged lengths, on others a very slight change, while certain of the measured lengths, those spanning cracks in the pavement, were longer at the lower temperatures.

It was found that transverse cracks which opened with a drop in temperature did not always entirely close again, but displayed a tendency to progressively increase in width. Probably that was due to fine particles of sand and abraded material of the pavement lodging in the open fissures. A repetition of the process caused a progressive lengthening of the pavement. During a period of 52 days one set of measurements showed the combined effect of decrease in temperature and progressive increase in width of crack amounted to 0.0395 in. This occurred on a pavement which had been laid about four months. The crosswise gaged lengths on the same street and during the same period of time contracted regularly with lowering of temperature, the maximum amount observed being 0.0039 in.

A number of earlier determinations on the coefficient of expansion of building brick gave a value in the vicinity of 0.0000040 per degree F. This value seems to fit the present tests fairly well. The observed changes were somewhat less than called for by the above value of the coefficient, but the actual range in the temperature of the brick was not ascertained with precision. Surface temperatures of the brickwork were used and not unlikely the range in mean temperature was less than the recorded amount.

Taking the observations as they were made, the contraction of the 40-ft. roadway of Euclid Ave. for a range in temperature of 100° F., was 0.1043 and 0.1101 in., respectively, at two sections of the roadway. The contraction called for on the basis of the above mentioned value of the coefficient would be 0.1920 in. That would be the total amount, one-half of which might be considered as affecting each side.

During sunny days, the temperature of the pavement naturally goes considerably higher than the temperature of the air a few feet above it. Observations on this feature showed a difference of 38° on one occasion. The temperature of the air was, on the day in question, 64° 4 ft. above the pavement. On the pavement, in the shadow of the curb it was 69°. In a freshly drilled pocket for a reference pin, on the sunny side of the street the temperature was 85°, while in the sun at the angle of the pavement and curb the thermometer rose to 102°.

In the laying of a cement-grouted pavement, a critical period is encountered at the very outset, during which care must be exercised just as in every cement structure, in order to avoid the formation of incipient cracks before the cement grout has had time to set and acquire strength. On account of the excess of water used in making grout the setting is much retarded and several days may elapse before a substantial degree of hardness is acquired.

During this period the pavement should remain at a constant temperature, if it were possible, day and night. A drop of 20° calls for a contraction of about 0.1 in. in a length of 100 ft. It is a fortunate circumstance in laying a pavement when a minimum range in temperature is experienced during the first 48 to 96 hours after grouting. Incipient cracks have been developed at a very early period following the grouting, resulting in injury to the street even before it was opened to traffic. Hot, sunny days followed by cool nights are menacing to freshly grouted pavements.

Transverse cracks have been started, which ultimately extended across the street, by the influence of the end joints of the edge stones against which the pavement was laid. The usual manner of laying pavements, with joints broken in one direction only, affords favorable paths for cracks once started to extend from curb to curb.

Recently an opportunity was furnished for inspection of the streets of the city of Panama, where brick pavements, cement filled, have been laid from five to six years. The pavements were without expansion joints at the sides and there were no street-car tracks. They were in very fine condition. In one place only were cracks of any kind noticed. At Panama the temperature is quite high throughout the year, and while the nights are cool, still the drop in temperature is not great. It is believed that equable thermal conditions have contributed toward maintaining the integrity of these pavements, and that pavements in Southern climates should in general be aided by the smaller range in temperatures over those experienced in the North.

CONCLUSION—The results now available point to the undesirability of bonding the pavements with street-car tracks, excepting possibly those of the very best construction. Cracks parallel to and adjacent to the tracks are likely to develop if the pavement is called upon to follow the usual elastic depression of the rails. Obviously there can be no lateral thrust to the pavement if the rails are left free to depress.

Strain measurements show that transverse expansions and contractions proceed with greater regularity than longitudinal movements. A progressive change in length or creep of a portion of the pavement is due to alternate changes of temperature, open cracks being partly filled with abraded material and prevented from closing when a rise in temperature occurs.

Cautionary warning is found in the behavior of pavements which have developed transverse cracks in the early stages after grouting. At this time exposure to a wide range in temperature is undesirable.

Pavements are probably benefited by a certain amount of compressive stress in a longitudinal direction. Transverse cracks will be kept closed so far as possible and, if the compressive stress is not excessive, spalling would not be induced. The open ends of paved streets, having no buttresses to take the thrust, may be expected to develop transverse cracks.

The minimum amount of crowning necessary to turn the water is advantageous to enable the pavement to resist compressive stresses without causing rupture during spells of sudden heating. Bends and reversed curves in streets are disadvantageous to the pavements.

A superior material is provided in paving brick of current manufacture, the use of which requires careful engineering skill, and it appears that questions pertaining to the effects of temperature changes are among those which require most prominent attention.

A Scheme for Conservation of Power from engines under test has been developed by the M. Rumely Co., of La Porte, Ind. According to a description of this scheme published in a recent issue of "Power," the kerosene engine tractors made by this company are each subjected to an engine test of at least 48 hours' duration before being shipped. To utilize the power developed by the engines under test, a row of electric generators is provided on an elevated platform down the middle of the testing shed. The engines being tested are belted to these generators.

There is space for 11 tractors on either side of the central platform and it is stated that at least six have been running under test at all times since the scheme was put in operation. The average power developed is given as 180 to 200 kw. This output is obtained without any additional expense for fuel, and while far from sufficient to meet the power requirements of the whole factory, it constitutes a notable saving.

A 60-Ton Refuse Destructor at Montgomery, Ala.

By John Primrose*

The city of Montgomery, Ala., with a population of 55,000 and area of 10 sq.miles, early in 1909 decided that a change would have to be made in the method of disposing of the household refuse. Until that time all of the city refuse had been dumped along the river bank, where it smoldered and decayed to such an extent that the city authorities were forced to take some action. After careful investigation of the various methods of disposal it was decided to put in a high-temperature destructor of the English type, of a capacity sufficient to dispose of domestic refuse of all kinds. A contract was entered into with the Destructor Co., of New York, for a Heenan furnace having a capacity of 60 tons per 24 hours, the plant to be located on a site belonging to the city near Railroad Street, between Court St. and Perry St. The plant was put into commission on May 24, 1911; officially tested on July 26, 1911, and subsequently it was formally accepted by the city.

Fig. 1 is a general outside view of the plant, and Fig. 5 shows a section of it. The material is carted to the plant over a bridge approach, from which the carts drive onto the third floor. Underneath this floor are the storage bins. The refuse is raked from the storage bins directly into the containers, which are shown in Fig. 2. Each of these containers holds a single charge for each one of the four grates into which the furnace is divided. The bottom of the container is closed by a sliding door, which also closes the opening into the furnace. These sliding doors are operated by an hydraulic ram, as shown in Fig. 3, and in order to charge the furnace it is only necessary to throw a small valve, bringing the ram into operation. The containers are kept full of refuse all the time, by an operator on the second floor, and the furnace is charged by the operator on the furnace or clinker floor, by means of the hydraulic ram, when the condition of the fires requires it. Fig. 4 shows one of the grates being clinkered. The clinker is broken up by heavy slice bars and dropped through a hole in the floor, provided by sliding one of the floor plates forward, into the clinker car, which runs on rails directly underneath the opening. This clinker car is operated by a steam-driven hoisting engine. After leaving the building it is pulled up an inclined clinker hoist, near-by, and dumped automatically when it reaches the top.

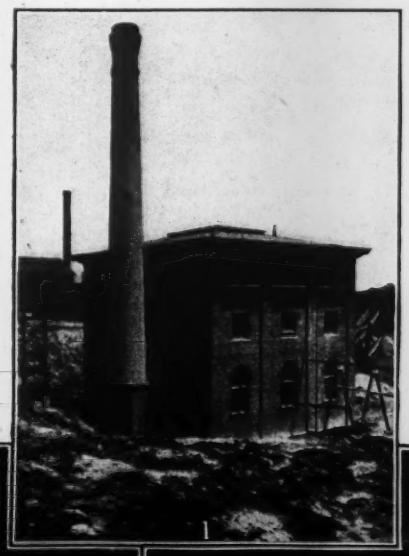


Fig. 3. Hydraulic Ram for Operating Top-Feed Charging Doors, and Turbine Driven Forced Draft Apparatus

Fig. 1. General View
Fig. 4. Clinkering the Furnace

Figs. 1 to 4. Views of Refuse Destructor, Montgomery, Ala.

Fig. 2. Charging Hoppers and Face of Furnaces

Four grates are arranged in a single furnace chamber, but the ashpits are divided. The air supplied for combustion is delivered into the ashpit through a valve, by which the quantity of air supplied to each grate can be varied to conform to the rate of burning.

The air for combustion is taken from ventilating ducts, which are distributed throughout the building, by means of a forced-draft apparatus which forces the air through an air heater and delivers it in the ashpit at a pressure of 4 in. of water and a temperature of 350° F. The gases from all four grates pass through a combustion chamber, where they are thoroughly mixed, complete combustion

*Chief Engineer, The Destructor Co., Power Specialty Co., Mgr., 111 Broadway, New York City.

insured, and the dust allowed to settle. The gases on leaving the combustion chamber pass through a water-tube boiler of 1800 sq.ft. heating surface, an air heater, and then enter the main flue and are delivered to the chimney.

The plant is somewhat larger than required for the present needs of the city. It is operated for periods varying from 8 to 12 hours, depending upon the quantity of material to be disposed of. The plant is found to operate most satisfactorily under these conditions. The surplus steam generated is used in the city water-works pumping station, located some 200 ft. from the destructor furnace.

The labor of operating the plant is divided as follows among two men: One man to keep the containers full of refuse, working on the second floor; and one man to stoke the fires and to clinker.

The material, which is burned without additional fuel, consists of rubbish and garbage, a small proportion of ash and some street sweepings.

The plant was installed under the following guarantees:

(a) That the residue from the furnace under ordinary working conditions shall be free from organic matter, thoroughly burned, hard and vitreous.

(b) That no nuisance shall be created in the ordinary operation of the plant.

(c) That neither obnoxious odors, gas, dust nor smoke shall come from the building or chimney.

(d) That the plant while operating as above shall destroy 60 tons of refuse per 24 hours, and when operating at this rate shall require three men.

(e) That the minimum temperature in the combustion chamber shall never fall fall below 1250° F., and that the average temperature of the combustion chamber will be about 1650° F.

These guarantees were more than fulfilled by the official test, a summary of which follows:

Duration	9.384 hr.
Total refuse burned	55,606 lb.
Rate of burning per hr.	5,925 lb.
Equivalent rate of burning 24 hr.	71 tons
Increased capacity above rating	18.4 %.
Total water evaporated	57,109 lb.
Water evaporated per hr.	6,080 lb.
Average boiler pressure (gage)	119.5 lb. sq. in.
Average superheat	189.3 °.
Total steam corrected for superheat	62,000 lb.
Equivalent evaporation from and at 212°	76,250 lb.
Equivalent evaporation per hr. from and at 212°	8,140 lb.
Equivalent evaporation per lb. of refuse burned	1.37 lb.
Boiler horsepower	236

The special features of this plant are the hydraulically operated top feed charging doors, already mentioned, the inclined side to the hopper, and the clinker-handling arrangement, all of which have greatly reduced the labor cost over previous plants.

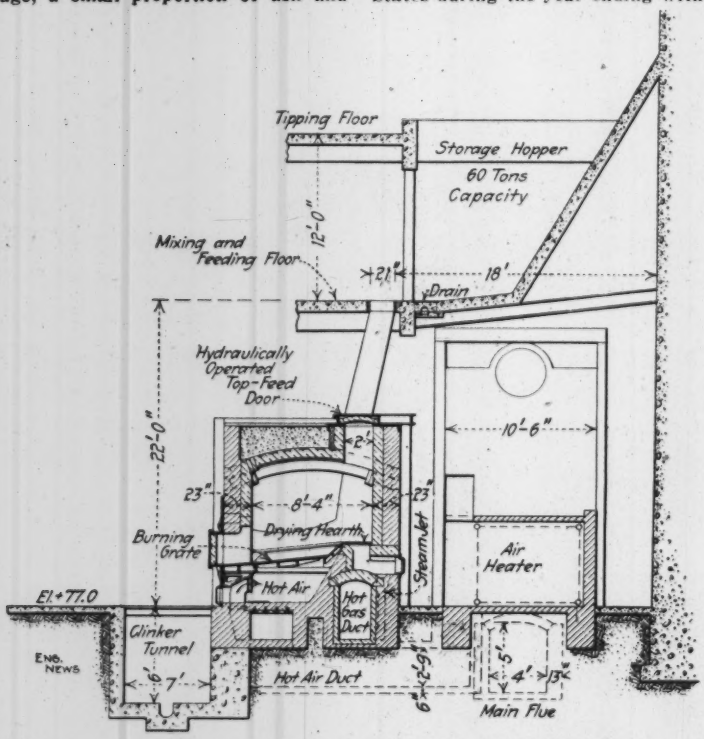


FIG. 5. SECTION THROUGH REFUSE DESTRUCTOR, MONTGOMERY, ALA.

Automobiles Exported from the United States during the year ending with June, 1912, will number about 20,000, with a value, including parts and accessories, of approximately $27,000,000. This statement is issued by the U. S. Bureau of Statistics, based upon detailed figures covering ten months of this year. About half of the automobiles imported into this country are supplied by France, which still leads the world in exports of automobiles. Of the 845 machines imported during the ten months ending with April, 1912, 339 were from France, 170 from the United Kingdom, 115 from Italy, 108 from Germany and 113 from all other countries. In late years, large numbers of used or second-hand machines are being exported from the United States to Canada, Mexico and the West Indies.

Traction Loading and Unloading Machines for Handling Loose Materials

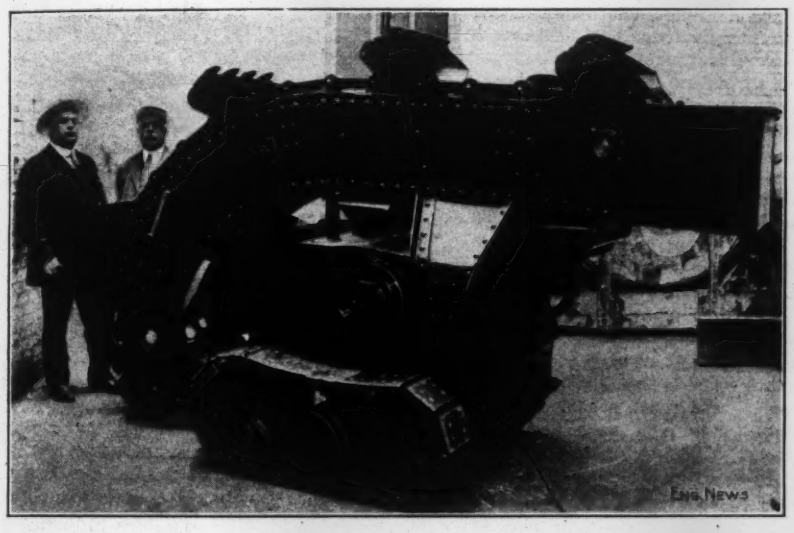
A light and compact portable machine for handling loose material is one of the latest developments in what may be classed as conveying apparatus, but although placed on the market only recently it is developed from a machine which has been used in actual service by its designer for some years. Its field is in handling rock, crushed stone, gravel, sand, coal, coke and like materials; it can take these from the storage pile, the gravel pit or the quarry and deliver them into cars, carts or wheelbarrows. The size, weight and cost are less than for a steam shovel or grab-bucket machine of equal capacity, the combination of high capacity and light weight in the loader machine being due to its continual moving of material in small quantities as contrasted with the moving of larger quantities intermittently by other machines. For work on a large scale, the same principles and apparatus have been applied to produce a machine capable of unloading materials from ships and railway cars. These various machines are designed, patented and manufactured by the Geo. W. Jackson Mfg. Co., of Chicago, which company has furnished us with information concerning them.

LIGHT TRACTION LOADER

The accompanying cut represents a handy machine of the type first mentioned, which is adapted specially for the use of the contractor and on general construction work. It is applicable also to other fields of operation. This particular machine weighs about 3 tons and can turn itself in its own length, so that it is very readily shifted in relation to its work. In over-all dimensions it is about 11 ft. long, 4 ft. wide and 6 ft. 7 in. high. The speed of travel is 75 ft. per min., and the machine can not only be moved readily upon or from a wagon or car, but it can be used as a tractor for shifting machinery or other loads. It will be seen that on the curved boom travel a pair of bar-link chains carrying a series of buckets; the buckets pick up the material at the lower end and discharge it at the upper and rear end. The form and size of the bucket are adapted to the character of the material to be handled. On the machine illustrated they are of 0.66-yd. capacity, the machine being built for loading phosphate fertilizer (at the factory); this material is very hard and has to be picked up from the stock pile and loaded into wheeled hand carts. For stone, gravel, etc., 1-yd. buckets are used and the capacity of the machine is about 200 to 250 yd. in a 10-hour day.

The boom and machinery equipment are mounted on a rectangular frame which is carried by a pair of "caterpil-

lers" having steel bearing plates or shoes attached to bar-link chains. The distance between centers of sprocket wheels is 3 ft. The roller in the middle, which rides on the lower or bearing side of the caterpillar, is set slightly below the sprockets so as to give this side of the caterpillar a slight convexity; this assists greatly in the facility of turning or swiveling the machine. A special feature of the design is that each caterpillar has its own motor and controller and is operated independently. With the motors running at the same speed in opposite directions the machine will revolve horizontally, practically pivoting on the vertical axis of its truck frame and turning within its own length. By varying the relative speeds of the motors the machine can swing or travel in any direction, so as to move to any desired point and to feed itself into its work. The operator stands on the ground (at the side of the machine), with a controller handle in each hand, and thus directs the movement, but a platform may be fitted to enable him to ride on the machine.



LIGHT AND PORTABLE LOADING MACHINE FOR HANDLING LOOSE MATERIAL
(George W. Jackson Mfg. Co., Chicago; Builder.)

Ordinarily there is a 5-hp. motor for each caterpillar and a third 5-hp. motor for the bucket chain, but a larger motor may be used for the chain on machines which are to handle very hard or heavy material. Steam, gasoline or compressed-air engines can be applied if desired. The machine is of substantial construction (built largely of structural material), being designed with a view to the severe service and rough usage which it is certain to encounter in its everyday work. No skilled operator is required to handle it.

In a modification of the machine illustrated, the boom is at a steep angle, and is carried by a structural-steel tower on the truck frame, the height over all being about 15 ft. 6 in. This forms a portable elevating conveyor suitable for loading material (through a chute) into dump wagons or railway cars.

LOADER WITH TURNTABLE SUPPORT—This is a somewhat larger and heavier machine in which the boom is carried upon a turntable on the truck frame, and the truck may be equipped either with caterpillars or with flat or flanged wheels. The arm which supports the boom is seated on a trunnion bearing on the turntable so that the boom can be set at any desired angle. Beneath the discharge hopper at the head of the boom is a horizontal belt conveyor 10 ft. long, the outer end of which is held by guys from the boom. This gives a sufficient reach for loading into the farther end of a quarry car or dump car backed against the machine. The conveyor is considered preferable to a chute, as the delivery is positive and there is little liability of choking or clogging. The boom can be revolved through a complete circle while its truck remains stationary. This machine weighs about 10 tons and in extreme dimensions it is about 28 ft. 6 in. long, 8 ft. wide and 14 ft. high. It can load 500 to 600 yd. of sand or gravel in a 10-hour day. Some of the machines have been in regular service for several months, loading blasted rock into quarry cars for delivery to a crusher plant.

GANTRY UNLOADER

This larger and more elaborate apparatus is developed on the principle of the machine above described, and is designed particularly for unloading loose material in bulk from ships, barges and railway cars. The traveling gantry or bridge spans one or more tracks, and for unloading ships it would have a cantilever projecting over the full width of the vessel. On the gantry travels a truck or trolley upon which is a turntable carrying a bucket boom. Where two or more tracks are spanned, there may be two or more unloaders on the bridge. The boom is raised and lowered vertically so as to handle material at any required level and to provide ample clearance for locomotives passing under the gantry. The buckets discharge their contents into a short lateral belt conveyor which delivers the material upon belt conveyor running the full length of the bridge. From this, the material may be discharged through chutes into cars or discharged upon a belt conveyor extending to any desired distance beyond the gantry in order to reach a stock pile or pit. In place of the longitudinal belt conveyors, there has been devised a conveyor consisting of an endless line of wheeled buckets traveling on a horizontal track following the sides and ends of the bridge. The buckets can dump at any point, a portable chute delivering the material to cars beneath the bridge.

For unloading railway cars, the buckets would be about 4 ft. wide and of 5-cu.ft. capacity, dumping at the rate of 16 buckets (say 70 cu.ft.) per minute. For rapid unloading of ore from ships the buckets might be very much larger, and it is believed that in such work a machine of this kind, with continuous operation, would compete very favorably with unloaders of the intermittent type, such as are now generally used. It is considered that the advantages of the newer type of machine would be in high capacity and low first cost, and also in the low maintenance and operating expense.

Reinforcing a Bridge in such a way as to make the added material share not only in the live-load but also in the dead-load stresses was done on the Bengal-Nagpur Ry., India, according to methods described by D. H. Remfry in a recent paper before the Institution of Civil Engineers. The bridge consisted of ten 200-ft. deck-truss spans, and two 100-ft. spans. Each span, during the reinforcing, was jacked up at six points, to take out most of the dead-load stress. The jacks were supported by falsework founded on 42-in. steel cylinders sunk in the sandy river bottom (and after using pulled and used again).

Special rivets were tried in the reinforcing, because some of the gussets furnished little room for driving additional rivets. The special rivets, of chrome-vanadium steel, had 45% greater shearing strength than mild steel, and, curiously enough, "tests seemed to indicate also that a greater bearing resistance could be relied upon in the plates, when these special rivets were used, than with mild-steel rivets."

The success of the reinforcing is described in the statement: "Practically no permanent set was observable on the first passage of a train after strengthening." The deflections of the spans under live-load were 26% to 30% less than before reinforcing.

"Men Wanted"*

By Charles Whiting Baker

The American college commencement is a remarkable institution. All over the country during this month of June, at hundreds of different colleges, the same scenes are being enacted. Students and faculty and alumni and plain ordinary people are all assembled, dressed in their best clothes. The student's parents are there, and his brothers and sisters, if he is lucky enough to have any. Perhaps he may be so lucky that some other fellow's sister will have enough interest in him to come and see him graduate. I hope so. It was so in my day.

And now, what is this all about? Why should these thousands of people leave their customary occupations to sit in a crowded auditorium on a hot day, listen to a speaker who tells them things they knew before and see a row of boys each handed a roll of parchment? Only this and nothing more! If this *were* all, then all of us might better have stayed at home today and stuck to our work. But this is not all. To some of the fathers and mothers in this audience this is not an ordinary college commencement. This is *John's* commencement day. What do the things matter that worried you yesterday, or last month, or last year? John is *graduating* today, and if John is the man he ought to be, and that I hope he is, then the worries and the self-denial it cost you to send John to college are all forgotten today. I congratulate John and all his brethren, whatever their names, on this his commencement day; but even more do I congratulate his and their parents. Life holds few greater joys for you than the joys which come in the success of those who bear your name and who are shortly to take your place.

So there *is* a very good reason for John being here and John's parents and his sisters and cousins and aunts and uncles. There is a reason, too, for the presence of the faculty, John's teachers, who have been his guides and counsellors and friends during his four years of study and for John's fellow students. But what good reason have the rest of us for being here? John is nothing to us, surely. He is only one of fifty thousand odd graduates which this month of June will see "kicked out of the college front door" as the old college song put it. What interest, then, has a college commencement for us?

And that reminds me of the question which every Freshman with the proper amount of curiosity asks; at least, I know I did. Why do they call it "commencement" when it comes at the end of the college year? Of course I got the stock answer—that the college year begins with the beginning of the summer vacation and commencement is to celebrate the opening of the college year. That satisfied me. It doesn't take much to satisfy a Freshman.

But I have learned some things since I was a Freshman. Is this great annual function—this week of examination and exhortation, of libation, oration and celebration, of song and dance and mirth and joy unconfined—is this all because it is the commencement of the college year? Nonsense! Who cares whether the college year begins on June 6 or on the Ides of March? The college can do its work without taking the best part of a week out of every year to glorify itself.

We may *call* it the college commencement—this celebration; but what we really celebrate is the commencement of their life work by a group of young men. To you, and you, and you, this is John's commencement; but to the rest of us, who don't know John, it is the entry of a new set of young men upon the battle of life, young men who it is supposed have had the advantage of four years of thorough preparation.

Four years did I say? Better call it eight or ten years. For while the average boy must leave school and go to work at 12 to 14 years of age, the boy who graduates from a college or technical school today must spend at least six to eight years more in study.

The presumption is, then, that by spending all these extra years learning how to make your life count, you can make it count to better advantage than your fellows who left school half a dozen years ago. They have been gaining education since in the school of hard knocks under that strict schoolmaster, Experience, while you have been living the sheltered life of school and college.

It is up to you, young men, to make that presumption good. For your Alma Mater's sake, for your parents' sake, for your own sake, you must show us that your education has been worth while. You may have faith in that proposition and we may have faith in it, but your Bible tells you that faith without works is dead, and the world will judge you by that standard.

It is a fact that the college and the technical school are today on trial; that our whole system of education is being subjected to searching criticism. That the question whether the college education of today is worth while is being asked by thousands of thinking men, a large proportion of whom are themselves college graduates. And the answer to this question is going to depend upon you men of the class of 1912 and '13 and '14 and '15: Of what you men who have had these great advantages make of your lives.

You are going to forget a lot of the things you have learned here in college. And you will be no worse off for it. You are going to forget a lot of the things I am telling you today—and which you knew before. But I believe you will remember what I am going to tell you now. You will think of it sometimes when you are downhearted and I hope at such a time it may give you new courage.

I have come here today to tell you that the world needs men; that the world wants men; that the world needs men more than it needs anything else. And that if you are the man you ought to be, the man you *can* be, the world wants and needs *you*.

I have said you are going to remember this because to some of you, perhaps to many of you, there will come times during the next few years when it will *seem* to you as if the world had no need whatever of your services. You have been educated in the technical lore of a profession which is overcrowded. You will write letters here, there and anywhere in search of a position, and as the monotonous answer comes back, "No vacancies," you will wish you were a butcher or a grocer or a milkman; that you could furnish something people had to buy every day, instead of engineering knowledge, which they seem to get on very well without.

At times like these you will be tempted to doubt my statement that the world wants you and needs you, so I must now try to fortify it.

In the first place, you have this much of comfort: That you are no worse off than the students graduating from other colleges and other college courses. It is true that you have fitted yourself to enter a profession already overcrowded; but statistics show that the overcrowding is far worse in the professions of law and medicine. It is true that the engineering graduate has to go out and compete with the boy who has been gaining practical experience during the half dozen years while the graduate has been working for a degree; but so must the graduate from a classical or literary course who goes into business compete with his brother, who quit school at 14, began at the bottom of the ladder and has now climbed up several rounds.

There was a time when it was a mark of distinction to be a college graduate. College education was for the few. Today it is the ambition of most well-to-do families to send their boys to college. The number of students at colleges and near-colleges has more than doubled in the last dozen years. Public high schools by the thousand all over the country are giving an educational training quite comparable with that furnished by the average college half a century ago. Then there are private schools in great numbers, normal schools in nearly every state and great systems of correspondence instruction reaching millions of students.

There is, indeed, no royal road to learning, now as in former years; but the road has been made so broad and smooth

*An address delivered at the Commencement of Rose Polytechnic Institute, Terre Haute, Ind., June 6, 1912.

that anyone may travel it, whether rich or poor, smart or stupid, wise or foolish. If one gate is closed, others are wide open.

Perhaps you say that these self-educated men or these fellows from the second-rate and third-rate schools don't count; that their competition need not be feared by the boys who graduate from a high-class college or technical school. I tell you not to deceive yourself. It is the student himself that counts far more than the institution. Parents worry over the choice of a college good enough for their little Willie. But if they can develop manliness and self-reliance and honor and industry in William while he is preparing for college, he will come out all right wherever he goes.

I know it is not painting a rosy future to tell you that you have no worse competition to meet than the boy who graduates from a classical or literary course; but there is something better than looking at bright prospects, and that is the courage to face facts. If an engineer deserves the name of engineer, he knows that the first requisite in solving any engineering problem is full knowledge of the facts. The problem before you of most importance is the problem of your life; and it is better for you to know what competition you must meet than to hear platitudes about the new worlds waiting for engineers to conquer.

I have to tell you, then, that so far as the engineering science you have learned in college is concerned, the supply of such learning is far in excess of the demand. And this excess of supply over demand is reflected necessarily in very low rates of pay for engineers. You can find engineers and scientists of mature years and long experience carrying large responsibilities and working for salaries little larger than the earnings of bricklayers and plumbers. I have no hesitation in saying that, compared with what it contributes to the world's welfare and the weight of responsibility it carries, the engineering profession as a whole is paid less than any other, unless it be the clerical profession.

Now, how are you going to change this condition? Some men say the trouble is that engineers are not big enough and broad enough men. So they propose to remedy it by keeping the boys shut up in school two or three years longer doing post-graduate work. I tell you that this is *not* the way to make engineers—the kind of engineers the country needs. Our engineering graduates have enough theory already. What they lack is the ability to convert their theory into terms of practice. If you are the men you ought to be, you need not fear the competition of the post-graduate engineers, whose commencement of life work is two or three years later than yours.

Other men say the trouble is that we have too many engineering schools and engineering students and engineering graduates in proportion to the demand. So they propose to keep down the number of students by raising the entrance requirements; and the number of graduates by making the courses stiffer and the examinations harder. Their scheme is to fix things so that nobody shall get into the engineering profession, unless they climb a very high fence of scholastic attainment. Is this the way to make the kind of engineers the country wants and needs? I tell you, No. I am far from undervaluing good scholarship in engineers; but I know the public will not pay a higher price for its engineering work because the engineer stood 20% higher in his college studies; and the public is right. Let us beware of training up a generation of scholastic engineers.

There are other people who want to have our legislatures build a tight fence around the engineering profession and open its gates only to those who have passed certain examinations. I say to you that it will be a black day for the engineering profession and a worse day for the public when this thing is done.

I can tell you in a single word the fallacy which underlies *all* these plans for bettering the condition of engineers. It is the fallacy that what the engineering profession needs is more learning. I tell you that what the engineering profession needs is more wisdom.

Nor need we confine it to engineering. We have in this country some six hundred institutions of higher education grinding out young men and women by the thousands and tens of thousands, equipped with alleged training. How many of them have gained wisdom in their college course? How many of them even come to realize the distinction between learning and wisdom?

I said the engineering profession needs more wisdom rather than more learning. Let me say to you, too, that what the public is looking for is *wise* engineers rather than *learned* engineers. The public doesn't understand and doesn't properly value learning; but it does recognize wisdom.

Here is an office of a great engineering concern engaged in building railways or water-works or machine tools or ships or typewriters. The heads of that concern will tell you that they have no difficulty in hiring engineers equipped with learning. They can hire computers and draftsmen and instrumentmen and erection men—all equipped with both book knowledge and practical experience; but they have to hunt for men who have the wisdom to apply their learning in the best way. Sometimes men of little learning have great wisdom. Do not make the mistake of underrating a man because he lacks the learning that a college training is supposed to furnish. He may be a man far wiser than you; and it is wisdom and not learning, sound judgment and not mere knowledge, which rates a man's real importance to the world.

But I fancy some of you are saying to yourselves that I am only repeating in different words the same old platitude about there being plenty of room at the top. The same old fallacy, really—for there isn't room at the top. The Pennsylvania R.R. has hundreds of engineers in its service and only one Chief Engineer. I know, as every sensible man knows, that most of us must be content with modest attainments and modest places in this world. Education ought to fit us to fill these modest places with fidelity. We need good sergeants in the army of commerce and industry quite as much as we need great captains and generals.

So when I counsel you that wisdom is the great thing to seek after, I mean to give you practical common-sense advice; advice that any of you can apply in a way to help you win victory in the battle of life. You may find it impossible to conquer higher mathematics or to be a neat and rapid draftsman, or to do accurate work in the field or the laboratory. Never mind, do the best that in you lies in whatever work you undertake and cultivate the qualities that every man possesses but most of us neglect. It doesn't sound like very much, perhaps, to say, live a clean, honest, temperate life; but more men fail from lack of this simple thing than fail because of lack of learning. It doesn't sound like very much to say, study courtesy to all, high or low, keep your temper, make friends wherever you go; but that advice carried out perseveringly will do as much for your success as all your engineering lore. It doesn't sound like much to say, be industrious; but the talent for hard work has won more prizes than have ever been awarded to genius. It doesn't sound like very much to say, work for your employer's interest as if it were your own; but that sort of fidelity is rare enough in these days, so that the man who cultivates it is laying a foundation stone on which to build his own success.

And now, I want you to consider with me the larger question: What ought to be the relations of the engineer—the college-trained engineer, if you please—to the public? What is the duty—the opportunity—of the engineering profession today?

Some of you may have heard a famous definition of engineering. It runs like this: Engineering is the art of making a dollar earn the most interest. Paraphrased it reads, The engineer is a man who can do with one dollar what any chump can do with two.

Now there is a large element of truth in these definitions. A large part of the practical everyday work an engineer does must be measured by the dollar standard. But I am one of those who believe that

this definition falls far short of what an engineer should be and should do.

Let us put the question fairly and squarely. Is the sole function of our engineering schools to train young men to build railways and ships and flying machines, so that we can travel farther and faster? Are we not forgetting in these days that it is not how far nor how fast one travels, but what the journey yields to one's life that counts?

Granted that our engineering schools may train up men of such skill and ability that our manufacturers can utilize this skill and ability to earn greater profits and pay bigger dividends. This is good, but is this the best that engineering can do? I say to you in all seriousness that if our engineering colleges have no higher purpose, if these crowds of graduates pouring out of the college doors mean nothing more than opportunities for manufacturers to hire technical ability at low wages—if that spells the highest purpose of our engineering schools, it is time to call a halt.

You have all heard of the farmer who toiled early and late to raise more corn to feed more hogs to buy more land to raise more corn to feed more hogs to buy more land, and so on. Wherein are we wiser if our engineering schools exist only to train more engineers to make more dollars earn more interest? Good and necessary though this is, it ought not to measure the limit of the engineer's achievement. It is important to our country's welfare that we shall have able engineers. It is even more important that our engineers shall be a high type of men.

Nineteen centuries ago a great teacher looked out on the flower-clad hills of Palestine and said, "Is not the life more than meat and the body than raiment?" Was there ever a time in the world's history when there was greater need for the race to ponder this question than today?

I repeat to you, seriously and solemnly, This world wants men. This world needs men more than it needs anything else. The world needs the kind of men that you have it in your power to become. And *why* does it need men? It needs them because the kind of a world this is to become is going to depend on the kind of men that each new generation brings forth. Did you ever think that it would take only a single generation of moral and spiritual decay to put this world back into barbarism, to destroy at one blow all the progress wrought by twenty laborious centuries of civilization?

I am no pessimist. I look with high hope and confidence on the future of our race, but I know perfectly well that that future depends on you and on the thousands of young men like you who are now taking up the responsibilities of life.

What is to be the future of our country? We are accustomed to think of our government as absolutely stable and secure. You are every one of you, I know, patriotic. If the nation were imperiled by war, none would be more ready to volunteer for her defence than the men in our colleges. I want to say to you that your country needs your faithful service as an intelligent, patriotic, wise citizen, just as greatly as it will ever need it in time of war. The perils that threaten our nation are just as real as the perils of warfare and they are even more dangerous, because they are understood and realized by few.

Our country will have no lack of patriotic service whenever and wherever her need is realized, but she needs wisdom as much as patriotism. There are already too many zealous, honest, well meaning reformers whose zeal far out runs their wisdom. What the world needs, what our country sorely needs, is *wise* leaders of thought and action. Where shall it look for them, indeed, if not among the men who have had the advantage of an education.

The *advantage* of an education!

What are our schools and colleges giving to their students? What means all this outcry of criticism upon our institutions of higher education? I can sum it all up for you in a nutshell. It all turns upon the question whether our colleges and technical schools are turning out men of high and fine character. If they are not doing that; if the idleness and the luxury, the sport and the vice that are dominating student life in many of our schools and colleges are to prevail in all, then I say to you in all seriousness that the colleges are undermining the foundations of our national welfare.

Do you think I state the case too strongly? Have you studied history? I don't mean the history which concerns itself with the lives of kings and queens. As Mr. Dooley remarks, "they were mostly a bad lot anyhow." What I mean is the history of peoples. Let me sum up for you, very briefly, the history of two peoples.

Less than three hundred years ago a few thousand men and women, plain, simple farmers and mechanics, landed on the cold, barren coast of New England. They builded there self-governing communities in which liberty and regard for law and order were given a new meaning. Of what account was that little isolated band of people, living in a wilderness beset by savages, well-nigh forgotten by the powerful monarchs of Europe? A hundred and fifty years went by, generation after generation came and passed away; but the high ideals and moral courage and nobility of spirit that came with the first shipload of those immigrants waxed stronger year by year. It spread to other pioneer communities scattered along the Atlantic coast. It inspired the Colonies to the sacrifices of the Revolution. It spread across the ocean to old Europe and under its influence kingdoms vanished and new nations were born. The descendants of those New England pioneers went across the Hudson, they followed the Great Lakes to the fertile prairies of the Middle West and the far shores of the Pacific. Wherever those descendants have traveled they have built churches and schoolhouses. They have inspired in all these communities devotion to the highest and best in life.

And now here is a contrast. For a century before the Pilgrims landed on Plymouth Rock, men of another sort were busy in the New World. All over that fair country of Central America, from Mexico to Peru, a country rich in a thousand natural resources, ranged the explorers of Spain engaged in a mad search for gold. And they found it in vast quantities, such as the world had never seen. Found it and fought over it like wolves. Sacrificed for it every law of God and man. Destroyed in their lust for it the civilization of Peru and of Mexico—a civilization far better deserving the name than that which the Spaniards brought. Go down to that country now. Go to Mexico, bleeding today in the throes of interminable revolution. Follow south all the way to Peru and see what sort of civilization and liberty and public welfare, what sort of peoples have been engendered from the ashes left by those Spanish fiends of three and four centuries ago.

Where was the difference between the Spanish explorers of the sixteenth century and the English colonists of the seventeenth? I can sum it all up for you in a word. The one worshipped gold; the other worshipped a high ideal of life. The gold long ago turned to dross and cursed those who won it. The ideal has blest all those who gave it allegiance and has borne fruit in all the nations of the earth.

We have heard much—but not too much—concerning the conservation of our natural resources. We have heard emphasized the fact that conservation of the public health is as important as the preservation of our forests and coal mines and water powers. I would urge upon you that our greatest need as a nation is to conserve such high ideals and fine character in our men and women that the life of all shall be worth the living.

It is that conservation which lies as a chief responsibility upon our colleges. It is their high task to cultivate the life of noble ideals. Out upon your college as a training school for money-grubbers. Out upon your college as a place for four years of jolly, care-free sport, with a few inconvenient things called studies interspersed. Out, I say, upon your college as a garden for dilettante culture. There are social and political forces gathering which may leave of such colleges not one stone upon another.

But long live the college which kindles in its students a burning zeal for the ser-

vice of their fellow men, devotion to the sacred traditions of the past with an open mind to the new problems of the future. In such institutions, by whatever name they may be called, rests the hope of our country's future.

I know well that I am stating no new proposition to you today. The facts I recite to you are being studied seriously by thousands of earnest men. But what I want to strongly impress upon you is that it is you students and you young alumni who have the largest responsibility in this and every institution to determine what the school shall be and shall do for its graduates.

It is your school's greatest work to develop fine character, high ideals and strong manhood in its students; but most of this work must be done, if done at all, by the students themselves. It is each one of you who is responsible for keeping the student body not only clean and honest and honorable, but enthusiastic over great causes and lofty ambitions. In four years of college life a youth will gain far more wisdom—or folly—from his student friends and associates than from either teachers or books.

My message to you today will not be in vain if it gives to some of you a new realization of the large responsibility which lies upon each and every one of you. It will not be in vain if it makes you understand that your success and the success of your associates in after life will depend quite as much on how you discharge this responsibility as on how you master your studies in engineering.

I have told you that men with engineering knowledge are plentiful; but I tell you also that men who combine with engineering knowledge, strong character, wise judgment and enthusiastic devotion to social and civic betterment—such men are all too rare. I tell you that thousands of towns and cities throughout this land are today wallowing in filth—moral and material—for the lack of just such men. But there are other cities where a single man or a small group of men, equipped with energy, courage, enterprise and honor, have organized the forces of industry and created prosperity. They have at the same time founded institutions of education and religion that have made their city a place worth living in.

You all remember the story in Genesis concerning Sodom and Gomorrah, those two wealthy, prosperous and utterly corrupt cities of the plain which were destroyed because of their wickedness. You remember that they were destroyed because there were not to be found in the whole city as many as ten righteous men.

I want to impress upon you the opportunities that lie open to tens of thousands of young men today all over the country. There are communities which fully deserve the fate of Sodom and Gomorrah, and which need saving from destruction by the moral and regenerative force of strong men in their midst as much as did those two cities.

We are confronted today by a multitude of difficult problems, moral, social and political. Never was there greater need of wise, patriotic public service by young men capable of filling places of responsibility than today. Do you say that this work is for lawyers and politicians and business men, and that the engineer has no part in it? I tell you that the engineer ought to contribute his technical knowledge toward the right solution of these problems and that the public will be led far astray and suffer grievous loss in many cases if it fails to seek the engineer's advice. I want to see in each community more engineers who are looked up to and honored because of their sound wisdom as well as their technical knowledge. I want to see more engineers of this type of manhood serving in our legislative bodies and filling high executive positions in the municipality, the state and the nation, as well as administering the affairs of great corporations. I want to see these things, not only for the sake of the engineers who may thus find large opportunities for public service, but for the sake of our common country and its welfare.

And now, if I have given you on this joyous day a long and serious discourse, my excuse must be my earnest desire to make clear to you what are your best opportunities for success, my desire to make clear how much your country needs the best service you can render it, not merely as an engineer but as a man.

To each member of this Class of 1912, and to each student of this Institute, I extend my best wishes for his future. Remember that the engineer's highest function is to be a leader of men. Thousands of engineers throughout the world today are doing this very thing, doing it with the patient heroism of Kipling's color-sergeant, who is described in the midst of his men in battle:

He's just as sick as they are.
His heart is like to split;
But he works 'em, works 'em, works 'em
Till he feels 'em take the bit.
The rest is holding steady
Till the watchful bugles play,
And he lifts 'em, lifts 'em, lifts 'em
Through the charge that wins the day.

Tests of Tile and Concrete Wall-Sections

The National Fireproofing Co. has recently had made for it a series of tests on sections of tile wall, varying from 4 to 10 in. thick and from 8 to 37 in. long, all about 12 ft. high. The tests were made by a well known firm of engineers. In each test the crushing load, and the lateral deflection and vertical compression under various loads were recorded. Wall sections of concrete, reinforced concrete, and brick, and interlocking tile, were included in the series, with the walls of plain tile laid both horizontal and vertical.

The results of the tests are summarized in the table below. In arranging this table we have computed the failure load in pounds per square inch of gross cross-section of wall, this being the quantity usually taken into consideration in designing.

Tests of single tile were made, one for each tile wall section. We give the results for comparison with the strengths developed by the walls. The great variations of ratio between wall strength and tile strength are to be noted.

The Panama Canal Lock Gate operating machinery has been tried and found satisfactory. The miter gate moving machinery for the first leaf completed in the construction of the canal was tested in operation of the leaf on May 13, at 9:30 a.m. The west leaf of the upper guard gate in the east chamber of Gatun Locks was swung from halfway position to closure, opened fully, closed, and drawn back to halfway position. The complete revolution of the bull wheel, a strut from which moves the gate, occupied 1 min. 48 sec., which is 12 sec. less than the time required in the specifications.—"Canal Record."

A Premature Blast on the Canadian Pacific Ry. in a rocky cut at Stone's Corners, in the vicinity of Kingston, Ont., June 1, caused the death of eight men and the injury of six others. Reports state that one man was blown to pieces by the blast and that the other victims were buried under stone and earth.

TESTS OF TILE, BRICK AND CONCRETE WALL-SECTIONS

Material	Age days	Tests of Walls About 12 Ft. High: Horizontal dimensions, inches	Failure load, lb. per sq. in. of gross cross-section		Comparison Tests of Single Tile: Bottom area, and position	Failure load, lb. per sq.in. gross sec.
Brick wall	47	8 x33¾	248			
Concrete wall	49	8 x36	1610			
Reinforced concrete walls	55	8 x36	2060, 1st loading 1920, 2d loading	no signs of failure		
Interlocking tile wall: side	13	8¼x37	288		8x12, side	600
Monarch tile pier (laid up of 4x8x8 tile on end)	25	8¼x 8¼	2685		4x8, end	8350
Monarch, 4" wall	25	4 x33¾	2560*			
Monarch 8" wall	47	8¼x37	1260			
Monarch 8" wall	35	8¼x37	1130		8x12, end, av. of three	2700
Monarch 8" wall	26	8¼x36¼	1680			
Natco 8" wall	28	7¼x35	570		8x12, end,	
Natco 8" wall	33	8 x36¼	1220		av. of two	3050
Natco 8" wall: side	28	7¼x36¼	280		8x12, side	350
Natco 10" wall; side	33	9¼x36¼	415		10x12, side	395

*Buckled

FIELD AND OFFICE

Standard Concrete Forms Used in the Philippines

BY R. McC. BEANFIELD*

In the accompanying drawings are shown the details of a few types of concrete forms which the writer has successfully used on numerous jobs, including several large reinforced-concrete buildings. One of the main features in the design of these forms is that scrap lumber, which is ordinarily wasted, is utilized where possible instead of the high-priced Oregon pine, which is the only desirable lumber to use for concrete forms in the Orient when accurate work is desired.

Economy in construction of forms and the handling of same is one of the largest items in the cost of concrete work. Forms that are easy to center, line, plumb and knock down cut down the cost of labor considerably. In the Orient, where mostly Filipinos, Chinese and Japanese carpenters are used, a superintendent is never sure of his form work being properly centered, plumbed, and braced, without a rigid inspection of the forms just before concrete work is started. Often he will find some of his columns or beams out of square or numerous other faults, thus delaying the concrete work with a prearranged concrete gang not in action. In order to avoid these faults the writer has tried to design his form work so that he is not wasting lumber and the forms give the least possible trouble in centering.

The wall form shown in Fig. 1 is the usual type of wall form used except that a base is first set to line by placing a 2x4 or a 4x4-in. stick flush to the wall line and bracing the 2x4's by blocks at intervals nailed to the concrete. Nails should be driven perpendicular to the face of the concrete, just enough to hold. On the 2x4, nail a 1x1-in. or 2x2-in. strip back from the wall line, say 3 in. in the clear, if ¾-in. lagging is used, so that the lagging will rest on the 2x4 with its face flush with the wall line. With the base so set, perfect alignment is assured and the only thing now necessary is to plumb the wall and properly brace with bolts. The spacing of bolts varies, of course, with the thickness and height of wall, but to be on the safe side and have a uniform spacing. The writer usually spaces bolts 2 ft. 6 in. on centers, covering about 7 sq.ft. of wall surface.

The beam form, shown in Fig. 5, is recommendable on account of its ease of construction, strength, and the ease of holding it to line. The sketch of the floor slab and beams shows the manner of erection. Note that the wedges used at the ends of the 2x6-in. joists tend to square and tighten the forms in general. Also note that a triangular strip is nailed

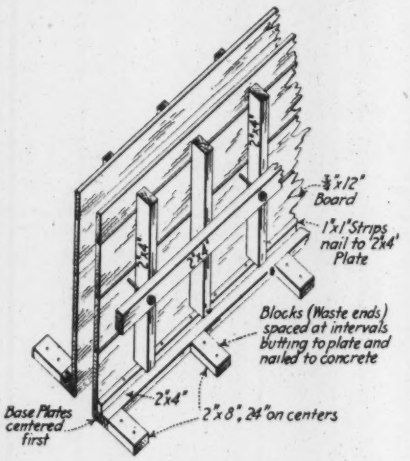

¾"x12" Board
1"x1" Strips nail to 2x4 Plate
Blocks (Waste ends) spaced at intervals butting to plate and nailed to concrete
2"x4"
2"x8", 24" on centers
Base Plates centered first

FIG. 1. ISOMETRIC VIEW OF WALL FORM DETAIL

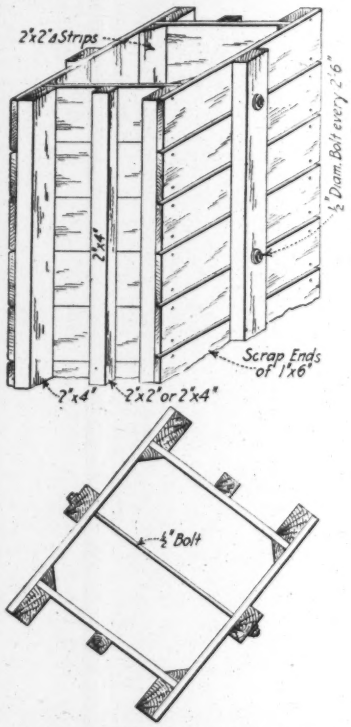


FIG. 2. DETAILS AND ISOMETRIC VIEW OF COLUMN FORM

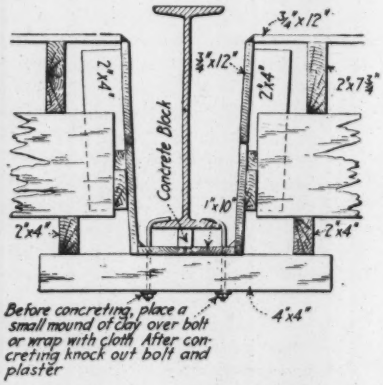


FIG. 3. DETAILS OF FORM SUSPENDED FROM I-BEAM CONSTRUCTION

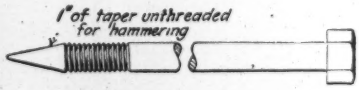


FIG. 4. FORM BOLT WITH NON-THREADED POINT

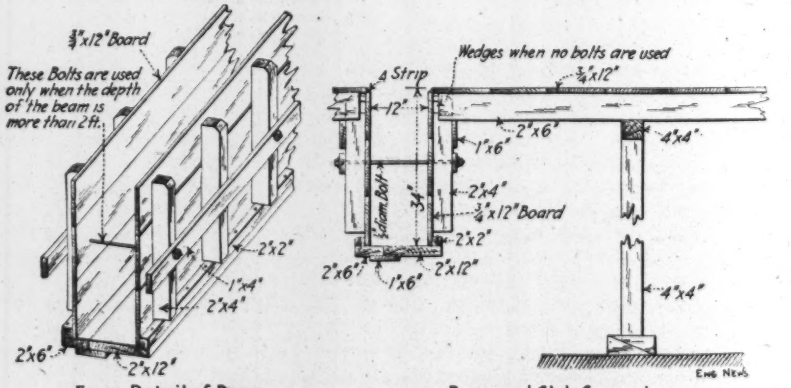


FIG. 5. DETAILS OF BEAM AND SLAB FORMS

STANDARD TYPES OF CONCRETE FORMS USED IN PHILIPPINE ISLANDS

*Assistant Engineer, Board of Public Works, Zamboango, P. I.

to the side of the floor form, thus allowing the sides of the beams to come out without jamming. In some cases the tops of the 2x4's on the sides of the beams are chamfered to facilitate the removal of the sides of the beams, which usually jam to the floor slab.

The column form shown in Fig. 2 is a very practical form, easy to handle, requires no surrounding braces or bands to tighten, easy to center and handy to take off after concreting. Another very good feature of this form is that scrap lumber, especially ends of 1x6-in. planks, can be used to very good advantage. This form can be poured full height in one operation without bulging, and the superintendent may have confidence in its holding powers.

The I-beam form (Fig. 3) has been used to very good advantage by the writer on steel buildings fireproofed with concrete and also on bridge work. No trouble was noted in extracting the hook bolts over the flange of the I-beam, as one would anticipate. A small mound of clay placed over the bolt or a piece of cloth wrapped on the bolt facilitates its removal. Tap the bolt slightly with a hammer toward the axis of the I-beam, extract, and slush up the hole with mortar.

On one building on which the writer was superintendent, the specifications called for all the concrete work to be suspended from the structural steel, mainly the I-beams. At first the common method was used of placing 4x4's over the top of the I-beams and suspending the floor and beam form by bolts passing through the floor slab, but as 1 in. of cement finish had to go on the floor slab in one operation, the 4x4's left an unsightly blotch, and the bolts also, which led the writer to devise the form shown in the sketch. This form eliminates the above faults as well as the hard job of punching the 22- or 24-in. bolts through the floor slab.

The form bolt shown in Fig. 4 has a taper of 1 in. to guard the thread, which is often burred when the bolt is hammered out of the concrete, thus saving the labor of rethreading the bolt and its transportation to and from the blacksmith.

Cantilever Forms for Concrete Retaining-walls*

By Thomas J. Kelly†

The accompanying sketch shows the cantilever system of concrete forming that is being used on lock walls at Mayos Bar, Coosa River, Ga. The first section is a stationary form, which is braced from the ground, the concrete being put in in lifts of 6 ft. each. In the second and succeeding lifts, bolts ¾ in. x 30 in., with nuts on each end, are put in the concrete 10 in. above the bottom and 10 in. below the top of the lift, and 4 ft. apart, leaving enough of the bolts outside of the concrete to go through the lagging, uprights and wales.

When the concrete has sufficiently set, the lower form is removed and holes bored in the wales to correspond with each bolt. The wales are then put on the bolts and uprights are put in between the wales and concrete, first putting one piece of lagging on top of the upper bolts, next to the face of the concrete; wedges are then driven near bottom end of the uprights, between the face of the concrete and the uprights, these wedges being used to line the forms and keep them rigidly in place.

The bolts should be left outside the forming, as shown in the upper left hand of the cut, until just before the concrete reaches this point; they should then be greased with "cable dope" and shoved in to the proper position.

Sometime during the next day, the bolts should be given a few turns with a wrench, so they will be loose in the concrete and can be removed at any time, and the holes plugged with neat cement. Nailing strips, 2x4 in., are used to tack the lagging together, and a strip of the same size is also used to secure the bulkhead, or end forming, in place.

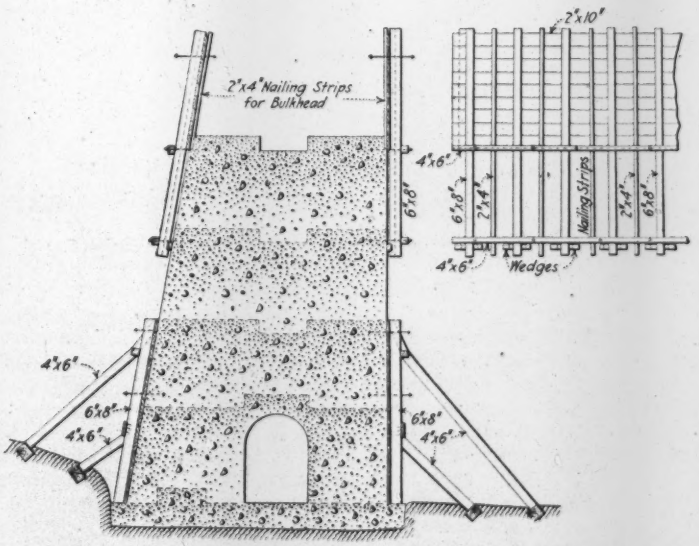
After the form has been used for the first time, the lagging can be taken up bodily with the derrick, and lifted to the next position, being allowed to rest on the top bolts while the wales are being bolted on; then the lower row of bolts can be removed and used repeatedly, with only the loss of one nut each time, which loss is inexpensive.

In the writer's opinion, this is the most economical system of forming in use today, both as to cost of material and cost of erection, for the lumber and other material can be used over and over repeatedly.

This system can be used to advantage on all classes of heavy masonry, such as lock and dam work, bridge piers and retaining walls; especially so where cyclopean masonry is used, as there are no rods or braces to obstruct the laying of large stones or in handling concrete buckets, and these forms can be used at a height of 100 ft., or more, as easily as at a height of 20 ft.

*From Professional Memoirs, Corps of Engineers, U. S. Army and Engineer Department at Large, May-June, 1912, No. 15, Vol. 4.

†Overseer, Mayos Bar, Coosa River, Ga.



Details of Cantilever Forms for Concrete Walls or Piers

Methods of Alignment in Three Aqueduct Tunnels

This article is a compilation of three separate contributions on tunnel alignment by three assistant engineers of the Board of Water Supply of the City of New York. The methods used in the first two instances were for aligning sections of the Catskill aqueduct, and the third is the method used on the Wachusett aqueduct of the Metropolitan Water-Works of Boston, Mass., in 1896-97.

Yonkers Pressure Tunnel

By James L. Davis*

The portion of this tunnel under contract 54 is 11,149 ft. in length. The cross-section is circular with finished waterway 16 ft. 7 in. in diameter, the largest on the line of the aqueduct and probably the largest pressure tunnel ever built. This contract includes three construction shafts of the following depths:

*Bryn Mawr Park, Yonkers, N. Y.

Shaft No.	Depth, ft.
1	154
2	106
3	116

The tunnel is entirely in Fordham and Yonkers gneiss and is a comparatively dry one, the amount of pumping required at the wettest shaft, No. 3, averaging about 70 gal. per min. The uptake shaft and 1200 ft. of the tunnel are under Contract 30, and are not included in this article. The distances are as follows, beginning on the north:

	Ft.
Portal to Shaft 1	2796
Shaft 1 to Shaft 2	3061
Shaft 2 to Shaft 3	3814
Shaft 3 to end of contract	1478

The alignment (Fig. 1) contains seven deflection angles as follows:

Between the portal and Shaft 1, 30°-30′-27″ and 22°-35′-28″.
Between Shafts 1 and 2, 00°-09′-41″, 43°-14′-36″, 43°-51′-41″.
Between Shafts 2 and 3, 1°-51′-47″.
Between Shaft 3 and end of contract, 20°-18′-23″.

Previous to beginning the work, stone monuments with copper plugs in the center were set at each angle about flush with the ground or street surface. In measuring angles four repetitions constituted a set and a series of four sets was read for each angle and its explement. A 5⅜-in. Brandis transit reading to 20″ was used. The following was the program in reading:

	Repetitions
Telescope direct, left to right	4
Telescope inverted, left to right	4
Telescope direct, right to left	4
Telescope inverted, right to left	4

The shafts were of sufficient width to permit placing the plumbing wires about 8.5 ft. apart. No. 8 steel piano wire was used. The 20-lb. lead weights were made in the form of a cross, with a staple and ring cast in the top. The wires were lowered from brass reels supported on a portable wooden frame and were lined in at the top of the shaft by a transit set near by. A slow-motion screw on the reel afforded precise transverse adjustment. The position of the wires was repeatedly checked during the time of observation below. The bobs were steadied in pails of water covered as much as possible to prevent splashing from dripping water.

At the foot of the shaft on either side a transit was set up about 15 ft. from the nearer wire and fudged into line. At this short distance the difference in focal length of telescope for the two wires completely extinguished the view of the nearer wire when the focus was set for the farther one, obliterating all obstruction of sight by the intervening wire.

Each observer transferred his line to roof scales on either side of the shaft by direct and reversed sights, revolving the instrument in azimuth between each pair of pointings. For illuminating the plumb-bob strings on which sights were taken at the roof scales various devices were used, the most successful being a cluster of electric lights behind a tracing-cloth screen supported in front of the bob string.

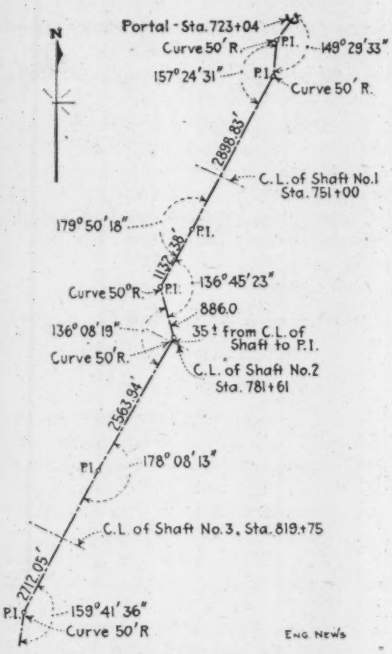


FIG. 1. YONKERS PRESSURE TUNNEL ALIGNMENT

When each instrumentman had obtained eight readings on each scale the men changed places, the instruments were disturbed and reset and the work was repeated. A Buff & Buff 5¼-in. transit was used in addition to the Brandis instrument previously mentioned. All work was done on Sundays, not less than three days' work being done at each shaft. The average total number of pointings on each scale was about 232. The mean of all readings was taken for the final line.

In transferring the line ahead to other roof scales about 48 pointings, direct and reverse, were made. Scales were placed about 300 ft. apart, on account of the smoke from shooting which remained in the headings and obstructed the sighting.

The entire heading was driven before the bench was removed, except for short distances each side of the shafts. In carrying the line ahead the transit was generally set up on the bench on an extension tripod and centered by a plumb-bob suspended from the roof scale, using the center mark on the telescope. Where the bench had been removed the transit was mounted on a trivet supported on a horizontal timber wedged across the tunnel about 3 ft. below the roof scale. At the portal the line was carried into the tunnel from a permanent backsight set about 3500 ft. away. No nearer location afforded an unobstructed sight on account of the descent of the profile in crossing the valley.

Levels were transferred down the shafts by means of a 200-ft. steel tape under a tension of 12 lb. minus the weight of the tape, between benchmarks set near the top and bottom of the shafts. Elevations were transferred from the top benchmark by direct reading on the tape with the level. Simultaneously the process was reversed at the bottom of the shaft, a direct reading on the tape being transferred to a rod held on the benchmark near by.

The headings met at about mid-distance between initial working points. South of Shaft No. 3 the work met the tunnel driven northward from the uptake shaft on Contract 30. For the 1200 ft. from the uptake shaft to the point of meeting the alignment is straight. This work was in charge of the engineers of Section 2 and will not be described here.

The following table gives the closing errors in line and grade, the measurements being made on the nearest roof scales and benchmarks, respectively, to

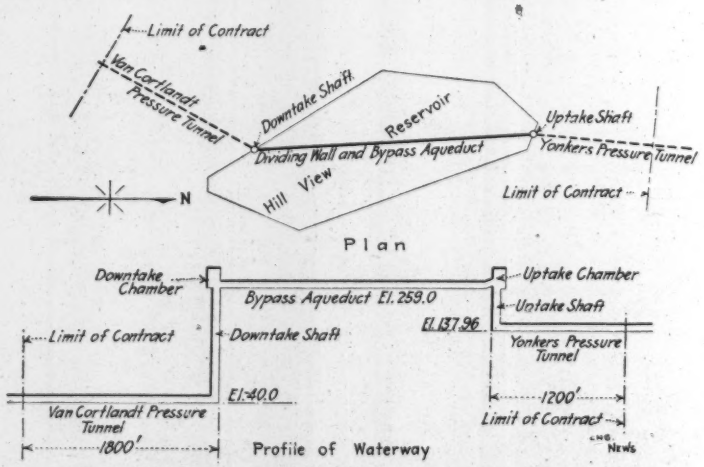


FIG. 2. PLAN AND PROFILE OF VAN CORTLANDT AND YONKERS PRESSURE TUNNELS

the points of meeting. The alignment was closed as soon as practicable after the holing-through shots, when sighting was more or less obstructed by smoke. The last set of observations therefore consisted of fewer readings and was less precise than earlier ones:

	Alignment error, ft.	Grade error, ft.
Portal to Shaft 1.....	0.05	0.02
Shaft 1 to Shaft 2.....	0.312	0.009
Shaft 2 to Shaft 3.....	0.041	0.016
Shaft 3 to Contract 30..	0.14	0.009

Van Cortlandt Pressure Tunnel

By Edward A. May*

This work was done on Contract 30, and the arrangement of shafts and tunnels is shown in plan and profile in Fig. 2. The Catskill aqueduct enters the Hill View reservoir through the uptake shaft, which is 140 ft. deep, and 1200 ft. of the Yonkers pressure tunnel is included in this contract. At the south end of the reservoir the downtake shaft, 310 ft. deep, leads the outflow to the Van Cortlandt pressure tunnel, which extends 1800 ft. to the contract limit.

The writer regrets that a complete check on the accuracy of the alignment work cannot be given, as the line was prolonged from the shafts only to the contract limit and no closure was made with one of the other lines reproduced in the same way. A closure was made in the Yonkers pressure tunnel [as noted in Mr. Davis' article.—Ed.].

The method used differs from the common one only in the manner of transferring the line from the wires to the roof scales underground. The work above ground was simple and conducted in the usual manner.

Two flat engineer's scales, graduated 50 parts to an inch, each mounted on a beveled piece of wood, were nailed to boards large enough to hold weights to keep the scales from moving. Powder boxes were placed in position at the foot of the shaft, one behind each wire, and upon these the mounted engineer's scales were adjusted normal to the axis of the tunnel in a horizontal position and about ¼ in. from each wire, as illustrated in Fig. 3.

Two roof scales, graduated to 0.01 ft. and reading from zero to 0.50 ft., were made fast to plugs in the roof, one about 50 ft. from the shaft and another about 200 ft. farther away. Sliding verniers reading to 0.002 ft. were mounted on the scales.

Beneath the first roof scale an 8x10-in. timber was wedged in place at a point convenient for setting up a transit on a trivet, about 3 ft. below the scale, and about 3 ft. below the timber a platform was erected on wooden bents for the use of the instrumentman. At the second scale a light temporary platform was erected.

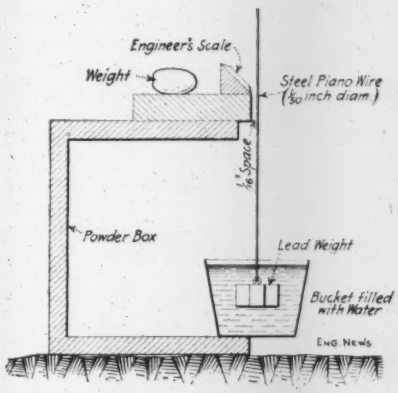


Fig. 3. Arrangement of Bob and Scale, Van Cortlandt Tunnel Alignment

The party consisted of seven, arranged as follows: above ground, instrumentman No. 1, with one man to adjust the wires to line; below ground, the chief of party (directing the work and recording notes), instrumentman No. 2, a man stationed at each wire, and one at the second roof scale.

After the wires had been suspended in approximate position they were examined from the cages to make sure that they were hanging free. Transit No. 1 was set up on the hub near the top of the shaft, transit No. 2 under roof scale No. 1, at an arbitrary point *A*, Fig. 4, known to be slightly off the true center line.

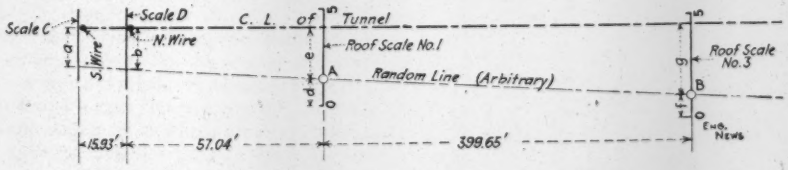


Fig. 4. Relation of Lines and Scales, Van Cortlandt Tunnel

The mounted engineer's scales were adjusted in position behind each wire, and a plumb-bob was hung by a short cord on roof scale No. 2, at a point *B*, Fig. 4.

The two wires were then brought to the true center line by instrumentman No. 1 on a direct sight and checked by a reversal, after which a signal was given to those below that all was in readiness for the observations.

The position of transit No. 2 under the first roof scale *D*, Fig. 4, was then recorded, as was the position of the backsight on the second roof scale *F*, Fig. 4, and the first set of observations began. The engineer's scales were illuminated by acetylene lamps with reflectors and the backsight by several candles placed in a box with a piece of tracing cloth in the front.

Instrumentman No. 2 made a setup at *A*, Fig. 4, sighting on *B*, plunged and read the position of the random line on each of the engineer's scales and took six such readings, alternately direct and reversed, as one complete set. Each time the instrumentman was setting on the backsight the men stationed at the wires took a reading of the wire position on the engineer's scales. This completed one set of readings and gave a numerical intercept between each wire and the random line *AB*, Fig. 4. The wires were then moved off and reset to line and the operations repeated. Four sets were taken in this way, making one series. After the first series both instruments were removed and reset, the instrumentmen changed places, the backsight was shifted to a new position, and four more sets of observations were taken as a second series.

The horizontal distances between wires, from the north wire to roof scale No. 1 and from roof scale No. 1 to roof scale No. 2, were determined by careful measurement and the position of the true center line of the tunnel on each scale was determined by using the average of the intercepts between each wire and the random line in a simple proportion.

When the excavation had advanced to a sufficient distance, a third roof scale was fixed in the roof at a distance of about 400 ft. from the first, and a determination of the center line on these two scales was made in the manner described, the line being checked on roof scale No. 2, which was afterward used only as a check to detect lateral motion in scales Nos. 1 or 3. With a 400-ft. base thus established, the balance of the line was produced by double reversals. Sundays were selected for doing this work, when the cages in the shafts were held at the disposal of the engineers and the atmospheric conditions were the best obtainable.

The principal advantages claimed for the method are that it obviates the necessity of sighting from the transit directly upon the wires and affords a means of taking a large number of observations in a limited time. The method is adapted to use in deep as well as shallow shafts, as in case of oscillation of the wires the limits of the swing may be read on the engineer's scales and the mean of these readings used.

It was found in practice that from a half to three-quarters of an hour was consumed in setting up the apparatus preliminary to making any observations and that each set of six readings took

*15 Park Ave., Mount Vernon, N. Y.

about 20 min. In other words, two series could be taken in about 4 hours, each giving a position of the tunnel center line on the roof scales.

The construction of the Hill View reservoir and adjacent tunnels is done for the Board of Water Supply, New York City, of which J. Waldo Smith is Chief Engineer and Frank E. Winsor, Department Engineer, Southern Aqueduct Department, and is under the immediate supervision of Charles E. Wells, Division Engineer, Hill View division.

Wachusett Aqueduct Tunnel

By Arthur W. Tidd*

The writer has had occasion lately to discuss various tunnel alignment methods and the fact was brought out in these discussions that it was almost always taken for granted that a clear atmosphere would be found in a tunnel. It is true that modern tunneling contracts usually provide for a ventilating system which will give clear sighting, at least at intervals, and it would only require a little planning to arrange for satisfactory conditions for transit work.

But a case of smoky tunnel might occur in spite of all provisions. With this thought in mind the following article has been written describing the work done in the Wachusett tunnel on the Wachusett aqueduct, a part of the Metropolitan Water-Works system of Boston, Mass., in 1896 and 1897; a tunnel in which adverse conditions for sighting precluded the use of the transit except at long intervals.

The aqueduct is a grade tunnel, horseshoe shaped, 10 ft. 10 in. vertical by 12 ft. 2 in. horizontal diameter of waterway, about two miles long, driven from four shafts and a portal simultaneously, with a progress averaging about 50 ft. a week at each heading. The deepest shaft was 130 ft., and there was an angle at each shaft. The following table gives the distances:

Shaft	Station	Distance, ft.
1	1 + 85	....
2	31 + 10	2925
3	58 + 55	2745
4	82 + 80	2425
Portal	105 + 00	2220

The excavation was in rock throughout, and was carried on by the ordinary heading and bench method, the bench being kept up to within about 50 ft. of the heading. Compressed air was used for all hoisting, drilling and pumping, and gasoline banjos and kerosene torches furnished light. The smoke given out by these lights was so dense that a plummet light could rarely be distinguished at a distance of 150 ft., and the tunnel was seldom entirely clear of smoke.

Under such conditions the transit was out of the question for taking line from the wires, and Fig. 5 illustrates the method used to overcome the difficulty. It was referred to at that time as the "string line" method when the subject was being discussed, and perhaps that term is as good as any. *ABCD* is the "string line," a random line approximating the center line, and *EFGH* represents the exact center line of the tunnel through the wires *F* and *G*. Fig. 5 shows in plan and elevation a sketch of the apparatus set up and ready for taking readings.

The "string line" was a long loop of bookbinder's linen thread, a scant $^1/_{50}$ in. in diameter, suspended freely between roof scales *A* and *D*. The points *B, C, F* and *G* mark the position of string and wires read on an ordinary flat engineer's scale, graduated to 50ths of an inch, fastened to an adjustable arm mounted on a tripod. The tripod was home-made, consisting of a wooden head, wooden legs about 24 in. long and an upright pipe 1 in. in diameter, all firmly attached to the head. The arm carrying the engineer's scale could be moved vertically on the upright pipe and also in a horizontal plane. By the combination of sliding joints and set-screws the scale could readily be brought into position above the string and close to the wire, and the position of wire and string read directly by eye.

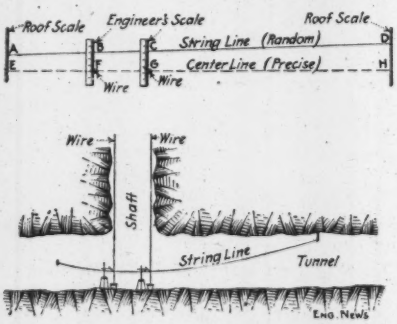


FIG. 5. PLAN AND PROFILE OF "STRING METHOD" USED IN THE WACHUSETT TUNNEL

The readings at *B, C, F* and *G* gave the intercepts *BF* and *CG*, and by knowing the distances between the wires and to each roof scale the distances *AE* and *DH* were computed (by similar triangles) and the roof scale reading for the exact center line determined. The distance between the wires was about 8½ ft. A 200-ft. base was thus established first, and another about 400 ft. long after the heading had advanced sufficiently.

The short base was not run with the extreme care that the 400-ft. one was, but each was taken from the wires, and on the long base, readings were taken on the intermediate roof scale as a check by means of a plumb-bob suspended from the vernier. No longer base was ever established, the line being produced by transit from these three scales, seizing the best conditions of sighting whenever they occurred.

This method worked well; it was not extravagant of time either in field work or office computations, and the following table which shows the actual distance between the lines at the point where the headings met (practically halfway between shafts) indicates the accuracy.

Shafts	Distance between shafts	Error in alignment, ft.
1	....	....
2	2925	0.11
3	2745	0.05
4	2425	0.05
Portal	2220	0.00

One party did all the work on this tunnel, and I think that four determinations from the wires were the most that we ever had time to make on any one of the 400-ft. bases.

Answers to some of the questions that will arise may perhaps be found in the miscellaneous notes which follow. The work above ground was similar to modern practice. The bobs weighed 25 lb. in air and were suspended in buckets of water. Portions of the shafts and tunnel were very wet; in such places, wherever the water struck directly against the wires or the string, or fell into the pail, vibrations were set up, and it was necessary to put up some protection. Such protection was rigged up by using building paper and ordinary furring strips. A fine spray or spatter, however, did not cause any disturbance.

The string hung quietly when thus protected, and no vibration, wave or drift was ever detected. It was always allowed to sag naturally, but a modification of the curve by attaching pieces of sheet lead had been considered, as a device which could be used if necessary to pass obstructions, to allow the readings to be more conveniently made, or to steady the string in case air currents were encountered.

The roof scales were brass, similar in design and operation to those in use at the present time. The scale on the back side of the shaft was fastened to the side wall at about shoulder height and the string stretched up so that readings at the wires could be made at about 3 ft. above the floor of the tunnel. The distance between the wires was measured several times at both top and bottom of the shaft and a check measurement taken at the top the last thing before the weights were taken off.

There were two different sets of observers below ground, each set reading roof scales, wires and string independently for each setup. The wires would be set on the surface with the telescope direct and all readings taken, then set with telescope reversed and all readings taken, the average constituting one determination of the true position of the center line on the roof scales.

Then the transitman would make a new setup, the wires would be moved off and

*215 Kimball Ave., Yonkers, N. Y.

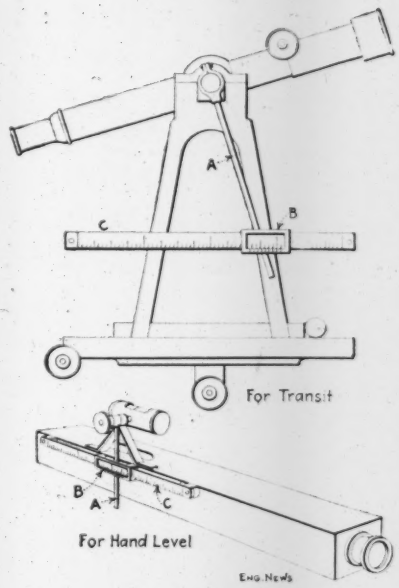
brought back to line again, the string line changed a tenth or so and the readings taken again. It took about 6 hours to make four determinations, exclusive of the time required to rig up the apparatus, which depended principally on the amount of water dripping from the sides of the shaft and the roof of the tunnel.

In a discussion of the comparative merits of this and other methods, it should be noted that the wires are under the constant and close supervision of an observer; any movement, either a long slow swing, a sudden vibration, or anything that would tend to vitiate the results, is immediately noticed and operations are suspended until the proper conditions are restored. The wire and string being close to the scale, any motion in either is at once apparent and its extent readily measured.

Thus a set of unreliable observations, which might otherwise go unsuspected until the computations were made in the office, is avoided and only a small amount of time is wasted instead of the half day's field work which might be required to repeat a set. A sudden shock, after which the wire or string quickly steadies itself again, often occurs and, if it comes back to its original position, it is usually safe to assume that normal conditions are restored, whereas a new reading even though on a steady wire would call for an investigation before proceeding. The slow swing of the wires in deep shafts, sometimes of many seconds' duration, introduces no complications, for readings can be made at both limits and the average used. On the Wachusett tunnel no determination was ever thrown out on account of the underground work.

Grade-Reading Attachment for Transits and Levels

A transit attachment somewhat resembling that described in our issue of Apr. 25, by Prof. R. L. McCormick, has been brought to our attention by F. W. Austin, Hartford, Iowa, who patented this device in 1909. It was designed for the purpose of giving a direct reading of rates of grade by means of the inclination of the telescope. In this design, a rod *A* is attached to the telescope trunnion and extending below it passes through a sleeve on the back of a vernier *B*, causing this to slide along a fixed horizontal scale *C* as the telescope is oscillated on its bearings. The scale is attached to the standards supporting the trunnion bearings. The device is shown in the patent as applicable also to a hand level. In this case (which also is shown in the cut) the scale is attached to the side of the telescope, with space enough between them to permit the radial movement of the rod, whose upper end is attached to the trunnion of the spirit level; the radial movement of the rod (as this level is tilted) shifts the sliding vernier along the scale. The vernier is graduated in feet and decimals of a foot.



TRANSIT AND HAND-LEVEL FITTED WITH GRADE-READING ATTACHMENT

Titles of Drawings: Their Relation to the Card Index

BY A. L. HEYWOOD*

Despite the growth of self-indexing methods of filing, card catalogs are still found in most drafting rooms, and their use can not be conveniently avoided. Nearly every published scheme of drafting-room management includes a card index for special phases of the business, or for general subjects which are not separate units in the system. All important offices and some smaller ones have elaborate rules for sizes of drawings, and size, style, and arrangement of titles, but these rules seldom refer to the relation of the titles to the index. Nevertheless, titles of drawings are the material out of which the index is made, and are much more important than the size or color of the cards on which it is written.

If the titles are vague, irrelevant or insufficient, the index will have the same faults. A title may even be satisfactory in itself, but if not similar in phrasing to titles on other drawings dealing with the same subject, the inconsistencies will appear on the index cards also. Concise, complete, and exact titles allow the use of low-priced labor in writing the cards, and such labor seems to be regarded as the most important requisite of any system. The engineer, who scorns a contractor erecting concrete structures with cheap foremen and loamy sand, will put the blueprint boy to the writing of an index and then wonder why he can find nothing in his files except what he remembers by main strength. The drafting room may utilize its resources to the utmost without the aid of an expert indexer by paying more attention when the drawing is on the board, to the fact that a record should be made from the title, and that that record will be consulted by people who know little of the special circumstances connected with and explaining the drawing.

The most simple plan for direct relation between drawings and the card index consists of using a rubber stamp for printing titles and having the stamp made of a size suitable for use on the record cards also. This method is of most use in offices where the titles are normally short, simple, and uniform. When used in drafting rooms dealing with varied subjects, more care will be needed to find titles fitting the space, the topic and the previous drawings in the same field, than if the ordinary methods of lettering are followed.

The relations of drawings to the index is of chief importance in establishments where the drawings deal with complicated machinery, which is approached with various points of view as renewals and repairs are required at considerable intervals of time. If the subjects are such as "Strap wedge and gib for wrist-pin box on Armington-Sims engine in the continuous rod mill," or "Friction ratchet spring lever for feed roll" of a typewriting machine, the arrangement of title requires more consideration from the indexing forces than when the drawing deals with a "Survey of John Smith's lot on Mud Street." But in any drafting room, time and annoyance will be saved and efficiency increased without additional expense by adjusting titles to the work of the past and the inquiries of the future.

The method of writing cards for indexes depends largely upon the arrangement of the catalog contemplated—that is whether alphabetical or classified. In order to keep the cards systematic and logical in arrangement the indexer must keep in mind several questions. If the title on the drawing answers most of those questions the work of indexing is expedited and simplified. It can be done by a person with less training and experience.

The ordinary indexer will naturally follow the wording of the title. The more completely the arrangement, phrasing, and information in the title corresponds to the requirements of a well written index, the more satisfaction will be given to those who turn the cards in their search for a dimly remembered drawing. The following rules for titles will assist in maintaining a consistent relation be-

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tween the drawings and the classified record.

I. In a set of drawings dealing with one subject, refer to that subject in the same way and if possible in the same order on each sheet. Make this reference so that it is clearly distinguished from other similar subjects, and do not omit it from any sheet to which it belongs.

The order of words is of special importance in an alphabetical index, and when the order varies on different drawings of the same subject, the unskilled indexer is likely to separate the cards. This fault is most liable to occur on tracings made at long intervals. It may seem a small matter to the draftsman whether he entitles his work "Throttle for locomotive crane," or "Valve for steam crane," but the stenographer who is in doubt as to the first being a bird or vehicle will be likely to put the cards in the index as far apart as locomotive and valve, although the apparatus was the same in each case. An "automatic counting machine" may be the equivalent of "consecutive numbering machine," but it does not show on the index cards.

It should be remembered that the fact that a trained draftsman can distinguish one tracing from another at a glance has nothing to do with making a card catalog. When he looks at the latter, he is quite as likely to be in doubt as the greenest office boy.

II. Do not add unnecessary adjectives or descriptive words to the title. Omit unimportant details.

In old establishments many phrases are still used in speaking of departments or apparatus, when no distinction exists. Often the added words record historical facts, but there is no need for constantly repeating them on drawing titles, when the space could be used for more pertinent terms. Of the same nature is the insertion of details that seem to be of great importance at the time, but become meaningless when the business of the moment is completed. If, after some discussion, an interurban railway decides to make all culverts of concrete, it is useless to insert the word "concrete" on every drawing of them. When other forms of culvert are introduced, descriptive words will become relevant.

III. Always insert the name of the person or department for whom a drawing is made, unless its application is entirely general.

In large establishments having several administrative departments which furnish suitable divisions for a classified index, the naming of them in the title prevents error by the card writer. Confusion sometimes arises from the use in different parts of the works of the same words for similar apparatus. The naming of the department is quite likely to be the only distinction that the index cards can show. Reels, rolls, cylinders, pistons, etc., represent too much variety to furnish identification, when choice must be made from a dozen drawings relating to machines bearing identical names.

IV. Where numerical systems have been adopted by administrative departments for designating buildings and apparatus, these same numbers should be used by the drafting room

In the absence of such systems it becomes necessary to determine a method by which drawings dealing with classes of machines of other subjects which are similar in general but differ in details, say be uniformly distinguished. Makers' names and serial numbers furnish convenient and certain identification, when they can be determined completely. Capacity and style of construction may do. Location of apparatus and use to which put is the most obvious and poorest system. The "Motor in the Machine Shop" can easily be moved to the packing room, and then both the drawing which has that title and the index card as well become ambiguous.

But whatever the system adopted, it should be consistently followed. Do not use maker's name on one sheet, location of apparatus on another, and type of machine on a third, if all the drawings refer to the same apparatus. These crudities are not likely to arise on tracings made the same month, but it is easy for inconsistencies to occur with the passage of years and draftsmen. Above all, avoid the use of words like "new," "old," "large," "small," and other relative terms, which, in the course of time become not only ambiguous but ridiculous.

V. Use nouns with prepositions rather than adjectives which are such only because written in the adjectival position.

The English language is not German nor Greek, but the same persons who would scorn the idea that those languages have some advantages over English, are most likely to imitate them in stringing together nouns without connectives, leaving the unfortunate who reads to decide which is noun and which is adjective, and probably finding no sense in either. It takes but little more space to write "Cylinders for operating switch" than to write "Switch operating Cylinders," but in the former case, the index maker will have far less trouble to decide whether switch is active or passive. If he is in doubt, far worse will be the case of the person who sees only the cards in the index.

Card catalogs can be made satisfactory only by the writer who constantly places himself in the position of one seeking information; but instead of that view being taken, cards are more often written with the drawing and its data before the indexer, who seldom has the imagination to realize that all those apparently obvious facts will be unknown to those who turn his cards in the years to come. If, in addition to that handicap, the drawing titles themselves do not convey exact and definite ideas, the value of the index is seriously limited.

Another Lucky Contractor—A few weeks ago we noted the finding of a coal mine in a Scranton, Penn., sewer tunnel. According to the Anaconda (Mont.) "Standard," a building contractor in Helena, Mont., has gone one better. From dirt excavated for a new hotel building three men are washing 3 oz. of gold daily. The report states that if the present yield is maintained the contractor will make more washing out gold than on his excavating contract.

Some Business Forms Used in an Engineering Office

By C. N. Bennett*

It frequently happens in an engineering office that the head of the firm is away a great part of the time and that only a small number of employees are employed steadily, the others being employed only for short periods. In some engineering offices in one of the larger cities, during a period of two years there would probably be not less than 100 different employees, probably not over six of whom would be employed continuously during this entire time, some working for only a couple of months before others take their place. It is necessary under these conditions to have as complete records of all work done as possible, so as not to be dependent on anyone's memory. Very often, too, work is carried on by an engineering firm at some distance from headquarters and it becomes necessary to arrange some system for keeping in touch with the work at frequent intervals.

The record forms to be described are the result of several years' experience and are the gradual outgrowth of systems and forms which were found to be inadequate. It has been found by actual experience that the clerical work required is easily taken care of to a degree depending on the results desired.

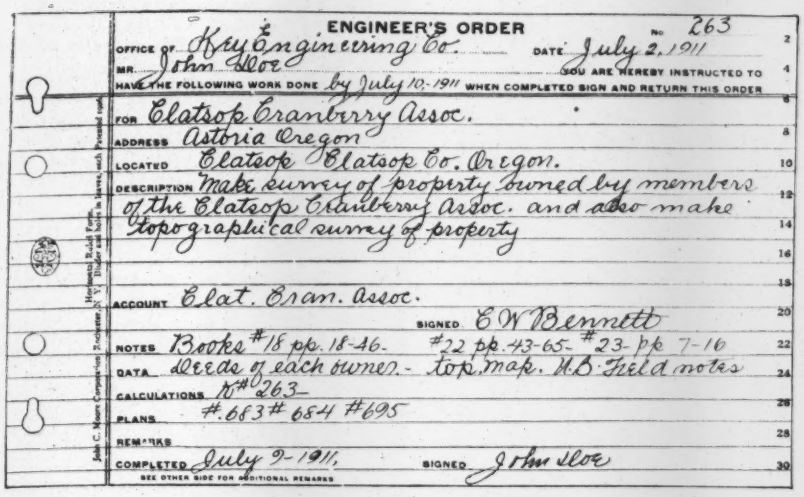
Work Order—The engineer's order, shown in Fig. 1, answers a number of purposes. It was devised principally for the purpose of laying out the work and to keep track of work which had not been completed. It also takes the place of considerable cross-indexing by showing all notes, plans, etc., used in connection with the survey. Each order is given a consecutive number when made out. This number should show on all time reports, plans, notes, data and calculations made in connection with the work. The data and calculations are to be filed under this same order number.

This order is made out in duplicate, the original is given to the party who is to have charge of the work, or is filed in the office where all employees can have access to it when it is not intended for any particular person. In that case, any person who is out of work can take it up. The copy is kept on file in the office until the original order is returned completed, when both the original and copy are filed away for future reference. The duplicates form a record of all work not yet completed.

Time and Cost Report—A daily report to be made out by the chief of each party in the field has been used by the author for keeping in close touch with the work. The form for this report was printed on an 8½x6½-in. sheet of stiff paper. On

*Warrenton, Ore.

the face of the card, in an upper corner, lines were provided for the identification of the work, giving practically the same



ENGINEER'S ORDER No. 263

OFFICE OF Key Engineering Co. DATE July 2, 1911

MR. John Sloe YOU ARE HEREBY INSTRUCTED TO

HAVE THE FOLLOWING WORK DONE by July 10, 1911 WHEN COMPLETED SIGN AND RETURN THIS ORDER

FOR Clatsop Cranberry Assoc.

ADDRESS Astoria Oregon

LOCATED Clatsop Clatsop Co. Oregon.

DESCRIPTION Make survey of property owned by members of the Clatsop Cranberry Assoc. and also make topographical survey of property

ACCOUNT Clat. Cran. Assoc.

SIGNED C W Bennett

NOTES Books #18 pp. 18-46. #22 pp. 43-65. #23 pp 7-16

DATA Deeds of each owner. - top. map. U.S. Field notes

CALCULATIONS No #263

PLANS #663 #684 #695

REMARKS

COMPLETED July 9-1911, SIGNED John Sloe

SEE OTHER SIDE FOR ADDITIONAL REMARKS

Hermetic Rubber Type, Jos. C. Moore Corporation, Rochester, N.Y. Binder and both in layers with Powder ink

FIG. 1. ENGINEER'S ORDER SLIP FOR KEEPING TRACK OF FIELD WORK

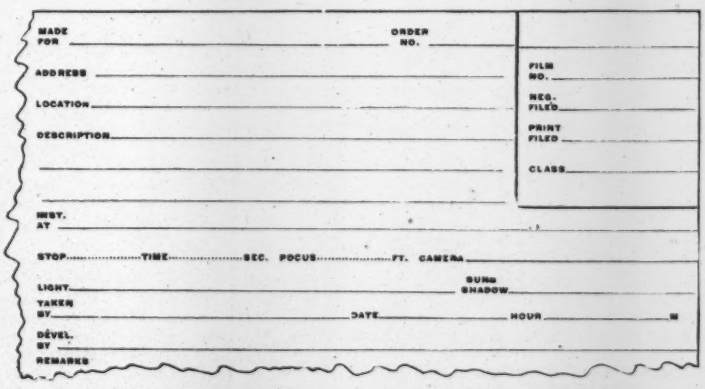
(Size of card, 8x5 in. Explanation: "Office of"—name of company or branch office; "Mr."—the man who is to be responsible for the work; the blank space in the next line can be filled with the date, at convenience, immediately, or any other suitable wording; "For"—the party for whom the work is to be done; "Address"—the mailing address of the above; "Located"—the location of the work; "Description"—description of the work to be done; "Account"—the account to which the work is to be charged; "Signed"—the signature of the person issuing the order; "Notes"—reference to the notes taken in connection with this order; "Data"—reference to data used in connection with this order; "Calculations"—reference to calculations made in connection with this order; these calculations should be filed away for future reference; "Plans"—reference to plans made in connection with this order; "Completed"—date when the work is completed; "Signed"—signature of person responsible for work.)

information as that on the upper half of the order shown in Fig. 1. The report was numbered to correspond with the order for the same work.

Columns were ruled off for the names of the several members of the party, and on horizontal lines below were entered the amounts due each man for his share in that part of the work described on the same line in the "description of work" column. Lines were arranged, too, for lost-time entries and explanations therefor under each name. On other lines were listed the distance and manner of traveling to and from the scene of work and the expense incurred in this way for each man. The final lines gave the time consumed on the work by each man.

At the foot of the report card, space was provided for a record of expenses incurred for lunch, etc., and on the back of the card was a form for an explicit account of the work done during the day and the materials, such as stakes, used in doing it.

This report should be made out daily and forwarded to the office each evening. The head of the office can in this way keep in close touch with all work underway in the field.



MADE FOR _____ ORDER NO. _____

ADDRESS _____ FILM NO. _____

LOCATION _____ NEG. FILED _____

DESCRIPTION _____ PRINT FILED _____

_____ CLASS _____

_____

INSTR. AT _____

STOP _____ TIME _____ SEC. FOCUS _____ FT. CAMERA _____

LIGHT _____ SUNS SHADOW _____

TAKEN BY _____ DATE _____ HOUR _____ M

DEVEL. BY _____

REMARKS _____

FIG. 2. FORM TO BE PRINTED ON ENVELOPES FOR FILING PHOTOGRAPHS

FILING AND INDEXING DRAWINGS

The author's method of filing plans or drawings is as follows: All original drawings are made on sheets not larger than 26x36 in. and filed in large envelopes made to hold them. Tracings are filed in tubes having a diameter of 2½ in. Blueprints are either filed in tubes or folded and filed in a vertical letter file of "legal" size.

A stiff-paper record slip, 6½x5 in., is filled out for each plan. The information called for on this slip is as follows: For whom made—name and address; location of work; description of the plans—several lines left for this; date plan was finished; scale; engineer in charge of work; owner of the plan; office, main or branch, where plan was made; draftsman; checker; references to notes, data, calculations and other plans used in preparing this one; the account to which the work is charged; place in which the plan is filed; kind of plans—tracing, blueprint, etc.; size of sheet; the heads or classifications under which the plan should be indexed or cross-indexed.

Index cards are prepared from these plan-record slips. The writer has found, however, that a card index does not answer this purpose so well as thin paper slips of card size bound in a loose-leaf binder.

FILING PHOTO FILMS

Envelopes printed on the upper corner of the face with the form shown in Fig. 2 are used for filing films up to 4¼x6½ in. This size has been found by the writer to be the best adapted for the result desired. The envelope was devised in order that any person could get all the information regarding any particular picture at any time. Each film is given a consecutive number and the envelopes are filed consecutively.

A card printed from the same form as the envelope is used to index and cross-index films and prints. It has space for more information than is necessary, as it is made from the same form as the envelope, and the lower part of the card is never filled out.

Notes

Concrete Survey Posts for marking the township and section corners in a forest reserve of 475,000 acres have been suggested by the U. S. Geological Survey to E. M. Griffith, State Forester of Wisconsin. According to a statement from the Survey, very satisfactory concrete posts have been made in conical forms of thin sheet iron, with locked joints like a stove pipe. To give these sufficient strength while the concrete is rammed into place, they are bound with several rings of heavy wire. As these forms cost only a few cents each, one can be provided for each corner and left in place, and will aid in protecting the cement from drying too rapidly. A 12-in. hole, 3 ft. deep, dug with a post-hole digger, is filled nearly to the top with cement and broken stone. The conical form is then placed on top of the soft concrete base, filled with cement and well tamped. A tablet is forced into the cement through the open top of the form. Heavy wire (plain, galvanized or barbed)

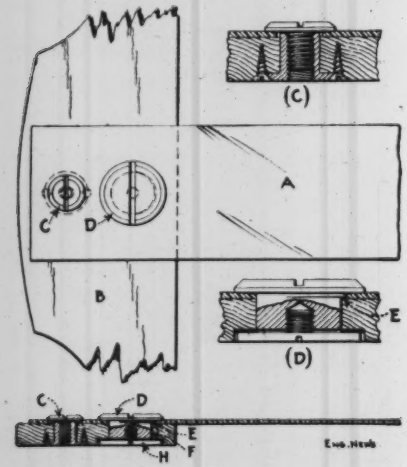
for reinforcing the posts will add considerably to their durability. If reinforced a top diameter of 4 in., increasing to about 6 in. at the ground surface, will probably give sufficient strength.

Steel-Bladed T-Square Heads — The note in our issue of Mar. 21, page 542, on this subject has elicited the following communication:

The accompanying illustration shows a square, the blade of which is adjustable on the head through a small angle. The head is made preferably of wood. The blade A is of steel. Two holes are drilled in the blade for the two clamping and adjusting screws C and D. The hole for D (which is the adjusting member) must be a snug fit for the eccentric portion of D located just under the head. The eccentricity of the portion E can be anything from a 100th to a 64th of an inch. The body F is a snug fit in the head.

The hole for the screw C is slightly elongated as shown to allow the blade to come and go as the eccentric screw D is turned. Obviously, the amount of this elongation must not be less than twice the eccentricity of E.

When adjustment of the blade becomes necessary, the screw C is eased very slightly; so slightly, in fact, that it still has a good grip on the blade and head. The lock screw H on the adjusting screw is also eased in the same manner and the eccentric can then be turned by means of a screw-driver in the slot of screw



T-SQUARE HEAD WITH ECCENTRIC ADJUSTING SCREW

D. When the head and blade bear the proper relation to each other, the screws C and H are tightened again. Care should be taken that the eccentric portion does not shift while the lock screw H is being tightened.

A. L. O.

New York City, June 4, 1912.

Superelevation on Railway Curves may be determined in very easy manner by a rule given by E. A. Hoffman, Engineer of Maintenance-of-Way, Wilkes-Barre Ry. Co., Wilkes-Barre, Penn. The rule requires no tables and the superelevation is measured directly from the track, so that it is unnecessary to know the degree of the curve. Moreover, the rule applies just as well to transition curves as to regular curves. RULE: Multiply the speed of trains in miles per hour by 1.6; the result is the length of a chord in feet whose middle ordinate is the proper superelevation for the curve.

For example, a trackman desires to superelevate a given curve for a speed of 30 miles per hour. The rule gives the chord as $30 \times 1.6 = 48$ ft. The middle ordinate of a 48-ft. chord is the required superelevation. In case the point to be superelevated is on a transition curve, half of the chord length, or 24 ft. in this case, should be measured in either direction from the point in question.

The rule is accurate and may be readily deduced from the formulas for centrifugal force and righting moment.

Eccentric Load on Piles or Rivets— The section modulus of a line of rivets or piles is ordinarily expressed by a formula containing the sums of the squares of the distances between rivets or (in case of equal spacing) the sums of the squares of the natural series of numbers or of the series ½, 1½, 2½, etc. The formulas are given in simpler form by W. W. Pagon, Fidelity Bldg., Baltimore, Md., as follows:

If

N = Number of spaces
R = Number of rivets (or piles, etc.)
P = Spacing
A = Sectional area of one rivet (or pile).

Then, for odd number of rivets; i.e., even number of spaces the moment of inertia is:

$$I = 2\,Ap^2\left(1^2 + 2^2 + 3^2 + \ldots \left(\frac{N}{2}\right)^2\right)$$

$$= \tfrac{1}{3}\,Ap^2\left(\frac{N}{2}\right)\left(\frac{N}{2}+1\right)\left(\frac{2N}{2}+1\right)$$

$$= \tfrac{1}{12}\,Ap^2N\,(N+1)(N+2)$$

For even number of rivets; i.e., odd numbers of spaces:

$$I = 2\,Ap^2\left(0.5^2 + 1.5^2 + 2.5^2 + \ldots \left(\frac{N}{2}\right)^2\right)$$

$$= \tfrac{1}{12}\,Ap^2N\,(N+1)(N+2)$$

The two formulas thus are identical. They may be written

$$I = \tfrac{1}{12}\,Ap^2n\,N(N+2)$$

The section modulus, equal to the moment of inertia divided by the distance from neutral axis to extreme fiber, is obtained as

$$\frac{I}{c} = \tfrac{1}{12}\,Ap^2n\,N\,(N+2) \div \tfrac{1}{2}\,Np = \tfrac{1}{6}\,Apn\,(N+2) = kAp$$

where k is a coefficient depending on the number of spaces. The following table gives the values of this coefficient for various values of number of units for spaces.

TABLE OF VALUES OF k

N	1	2	3	4	5	6	7	8	9	10
n	2	3	4	5	6	7	8	9	10	11
k	1	2	3⅓	5	7	9⅓	12	15	18⅓	22

N	11	12	13	14	15	16	17	18	19	20
n	12	13	14	15	16	17	18	19	20	21
k	26	30⅓	35	40	45⅓	51	57	63⅓	70	77

Mr. Pagon points out that the formula and table are just as much applicable to a line of piles (as under a wall where the load is not directly over the middle of the line of piles) as to a line of rivets. In the case of rivets, the section modulus or moment of inertia may be applied to forces which produce torsion in the joint (as in the case of the end connection of an I-beam) as well as to forces which produce tension on the rivets at one end of the line (as for the rivets in the outstanding legs of the connection angles at the end of a beam).

Accurate Indoor Leveling for setting shafting and similar work in shops may be accomplished with a water level by a method described in "Engineering," of Mar. 1, by G. H. Millar. The water-level consisted of two tripods standing on the two places whose relative elevations were required. Each tripod carried a vertical scale, the elevation of the zero of which above the bottom of the tripod was known. The tripods had each a micrometer hook-gage, which had to be vertical, and were set up over two vessels of water, connected by a 1-in. hose. A convenient method of making the hook-gage is to have a vertical screw of 25 threads to the inch with the micrometer head a disk with 40 divisions on the circumference reading on a vertical scale graduated to $\frac{1}{10}$ in., thus giving elevations to $\frac{1}{1000}$ in. One of the micrometer disks should be made adjustable so the readings may be made the same on both. It is essential to exclude all air from the connecting hose, which may be done by squeezing it. Air drafts must be kept from the surfaces of the two vessels. The level so obtained has, of course, the curvature of the earth's surface, about 0.0036 in. in 1000 ft.

Motion Pictures of the Work on the Engle Dam, at Elephant Butte, N. M., on the Rio Grande reclamation project have been taken by Geo. M. Peters, of the Selig Polyscope Co. In addition to pictures taken from a moving train on the track from Elephant Butte Junction to the dam site and others showing the cableway across the Rio Grande at a height of 500 ft. above the water, a series of pictures which should be of great interest were taken from a basket suspended from the cableway itself. The operator with his camera in operation was lowered from the cableway into the foundation pit at the west bank of the river, which is now more than 65 ft. deep, and subsequently the basket was raised again to a height of about 400 ft., and pictures taken with the camera aimed downward while three heavy blasts were fired in the pit. The basket was then moved to a position above the river and lowered almost to the surface of the water. During the descent, which was made at the rate of 12 ft. per second, the camera was turned through a complete circle so that the views obtained will take in the entire work, showing a panorama of the dam site. Press reports state that these pictures will be exhibited generally in Europe and America. This is a part of the movement to give publicity through motion pictures to all important works carried on by the government, which has been going forward during the past year or two with the full support of government officials.

Cement Gun at Panama—The coating of cement mortar applied by the "cement gun" which was sent to the Isthmus of Panama a little less than a year ago for use in spraying the surface of certain rock faces in Culebra Cut, which disintegrated on exposure to air, was found not to prevent this disintegration. The concrete mixture sprayed on the smooth surfaces adhered uniformly, but was not sufficiently airtight to retard appreciably the progress of disintegration.

The gun was used recently on the relocated line of the Panama railroad, in coating the surfaces of hand-laid revetment wall, made of hard Bas Obispo rock. In this case the concrete penetrated the interstices between the rocks as far as several feet and thus obtained a firm hold. Using a mixture of 1 part of cement to 3 of sand for the inner coating, and of 1 part of cement to 2 of sand for the final surfaces, it was practicable to lay a smooth, strong coat from 2 to 3 in. thick, over an area of about 25 ft. square a day. The spraying was continuous. By the time the work had been carried from one end of the area under treatment to the other the first part was ready for another coat. In all, about 10,000 sq.ft. of revetment was treated.—"Canal Record."

Clearance Table for Diagonal Connections

The table herewith, made by R. G. Brown, Johnstown, Penn., is designed to avoid the necessity for "laying out" diagonal connections in order to determine the necessary clearance-spacing of rivets and size of the connection plate required.

A New Kutter Formula Diagram

By K. R. Kennison*

The accompanying diagram for the Kutter formula is the result of several months' study to put this much used formula into compact convenient graphical form. In many computations of flow in the Mississippi, Missouri, and other rivers, this diagram has saved about 75% of the time used in making such computations by the only other Kutter diagrams which, as far as I know, are available.

You are doubtless familiar with the complicated Kutter diagram prepared, I believe, by Messrs. Rudolph Hering and John C. Trautwine, Jr., from which, after carefully flattening it out, one can with a straightedge find, when the other three are known, any one of the four variables R (hydraulic radius), S (slope), n (coefficient of roughness), or C (the constant in the equation $V = C\sqrt{RS}$). Prof. I. P. Church has to some extent improved upon this by preparing a set of several diagrams, each for a different constant value of n, which eliminate the necessity of dealing with C and enable one to find, when the other two are known, any one of the three variables S, V or R. It is impracticable, however, to find n from the other three variables.

Other authors have arranged graphical solutions of this Kutter formula, but I know of none which, like the one here presented, puts upon one small sheet all the information which can be desired and enables one to find almost at a glance any one of the four variables V, S, R or n when the other three are known.

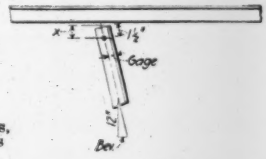
In its present form this diagram could not be used, except approximately by extrapolation, when very low values of S (slope) are involved; but the writer believes from considerable experience in its use that its scope is amply adequate, particularly in problems where the flow is in rivers and other natural channels.

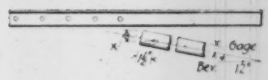
In connection with a notable power project now in process of construction, the writer has used this diagram in estimating back-flowage conditions in flows varying from 20,000 to 300,000 cu.ft. per second and with many varying pond levels.

*815 Banigan Bldg., Providence, R. I.

TABLE OF CLEARANCE OFFSETS FOR ANGLE WEB-MEMBERS

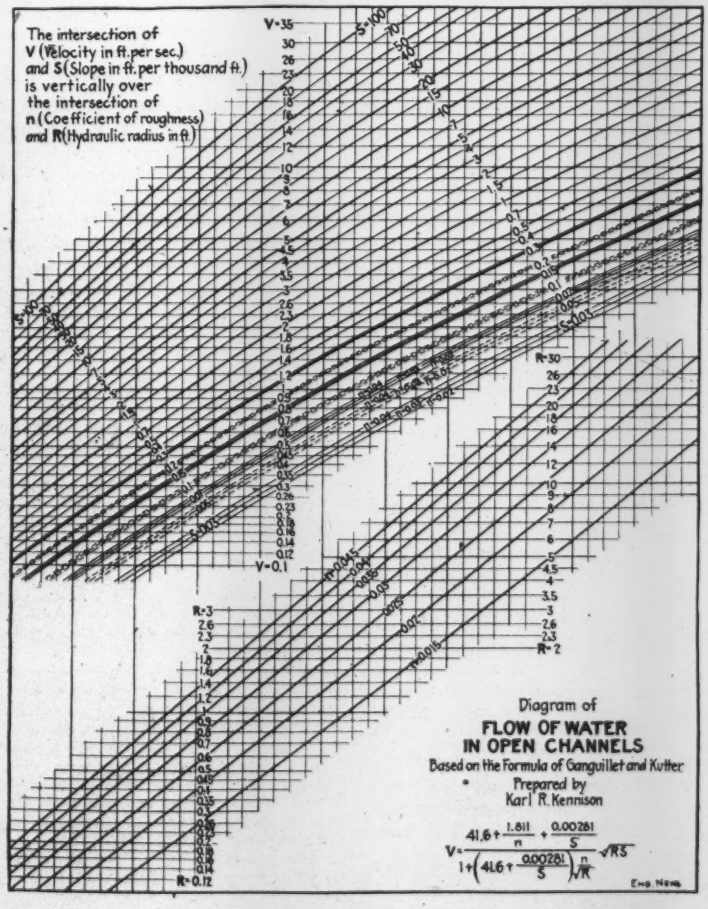
(Distances "X" for Various Gages and Bevels)





Bevels, inches per foot	Gage 1	1⅛	1¼	1½	1⅝	1¾	2	2¼	2½	3
0	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½
¼								1½	1⅝	
½						1⅞	1⅞	1⅞	1⅞	1⅝
¾								1⅝	1⅝	1⅝
1	1⅝	1⅞	1⅝	1⅝	1⅝	1⅝	1⅝	1⅝	1¾	1¾
¼							1⅝	1¾	1¾	1¾
½					1¾	1¾	1¾	1¾	1¾	1⅞
¾							1¾	1¾	1⅞	1⅞
2	1⅝	1⅝	1¾	1¾	1¾	1¾	1¾	1⅞	1⅞	1⅞
¼								1⅞	1⅞	2
½					1⅞	1⅞	1⅞	1⅞	2	2
¾								2	2	2
3	1⅞	1⅞	1⅞	1⅞	1⅞	1⅞	2	2	2	2
¼										2
½							2	2	2	2
¾										2
4	1⅞	1⅞	1⅞	1⅞	1⅞	2	2	2	2	2
¼								2	2	2
½								2	2	2
¾										2
5	1⅞	2	2	2	2	2	2	2	2	2
¼										2
½										2
¾										2
6	1⅞	2	2	2	2	2	2	2	2	2
¼										2
½										2
¾										2
7	1⅞	2	2	2	2	2	2	2	2	2
½										2
8	2	2	2	2	2	2	2	2	2	2
9	2	2	2	2	2	2	2	2	2	2
10	2	2	2	2	2	2	2	2	2	2
11	2	2	2	2	2	2	2	2	2	2
12	2	2	2	2	2	2	2	2	2	2

Gage 1	1⅛	1¼	1½	1⅝	1¾	2	2¼	2½	3
1	1⅛	1¼	1½	1⅝	1¾	2	2¼	2½	3
1⅛	1⅛	1⅛	1⅛	1⅛	1⅛	2⅛	2⅛	2⅛	3⅛
1⅛	1¼	1⅜	1⅝	1¾	1⅞	2⅛	2⅜	2⅝	3⅛
	1⅛	1⅛	1⅛	1⅛	1⅛	2⅛	2⅛		
1⅛	1⅜	1½	1¾	1⅞	2	2¼	2½	2¼	3⅛
1¼	1⅛	1⅛						2¾	
1⅛	1½	1⅝	1⅛	1⅛	2⅛	2⅛	2⅛	2⅛	3¼
1⅛	1⅛	1⅛	1⅞	2	2⅛	2⅜	2⅝	2⅞	3⅛
1½	1⅝	1¾	1⅛	2⅛	2⅛	2⅝	2⅞	3⅜	
1⅛	1⅛	1⅛	2	2⅛	2¼	2⅛	2⅛	2⅛	3⅜
1⅝	1¾	1⅛	2⅛	2⅛	2⅝	2½	2⅛	2⅛	3⅜
1⅛	1¾	1⅞	2⅛	2⅛	2⅝	2½	2⅛	2⅛	3⅛
1⅛	1⅛	1⅛	2⅛	2⅛	2⅛	2½	2⅛	2⅞	3⅛
1¾	1⅛	1⅛	2⅛	2⅛	2⅛	2½	2⅛	2⅞	3⅛
1¾	1⅞	1⅛	2⅛	2⅛	2⅛	2½	2⅛	2⅛	3⅛


The intersection of V (Velocity in ft. per sec.) and S (Slope in ft. per thousand ft.) is vertically over the intersection of n (Coefficient of roughness) and R (Hydraulic radius in ft.)
Diagram of
FLOW OF WATER IN OPEN CHANNELS
Based on the Formula of Ganguillet and Kutter
Prepared by
Karl R. Kennison
$V = \frac{41.6 + \frac{1.811}{n} + \frac{0.00281}{S}}{1 + \left(41.6 + \frac{0.00281}{S}\right)\frac{n}{\sqrt{R}}}\sqrt{RS}$
Eng. News

Letters to the Editor

Ferryboats Propelled by the Current

Sir—I have read with interest the article in ENGINEERING NEWS of May 30 describing a current-propelled ferryboat on the Cumberland River at Clarksville, Tenn.

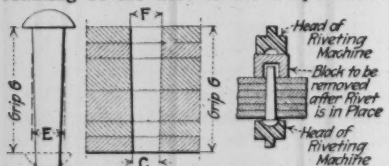
Ferries somewhat similar to the one described have frequently been used on fast-flowing mountain streams in western Canada for the transportation of men and materials during bridge construction. The method generally adopted is to first stretch a stout steel cable from bank to bank at right angles to the direction of the current and sufficiently high to clear all river traffic. On this cable is adjusted a system of pulleys connected directly to the ferry by means of the short bridle cables described in Mr. Chappell's article. By properly adjusting aboard the vessel the lengths of these short cables, the vessel is made to travel across the river, the pulleys traveling along the long cable.

This method requires no buoys and has proved efficient and economical for transportation purposes.

GEO. G. MACLENNAN,
Minnedosa, Manitoba, June 5, 1912.

Taper Rivets in Taper Holes for Long Grips

Sir—The writer believes that the design of rivet shown herewith, for grips of 3½ in. or longer, will eliminate the many objections to the standard cylindrical rivet. In the first place the cost would not be greatly increased. The reaming of the hole to the shape shown



DESIGN OF TAPER RIVET AND TAPER HOLE

could be accomplished as easily and cheaply as reaming to cylindrical shape, while it would only require a change of dies in the rivet-making machine to forge the rivet to the shape shown. It is believed that the assurance of a greater percentage of sound rivets is well worth the difference.

FRANK E. SMITH.
316 N. 9th St., Atchison, Kan.

[Tapered rivets were used with great success by the McClintic-Marshall Construction Co., in building the Beaver Bridge, two years ago. Tests showed that for long grips these rivets filled their holes well, while straight rivets did not. The holes were cylindrical, we believe. —ED.]

Government Tests of Wire Rope

Sir—The Bureau of Standards has decided to make a series of tests upon wire rope and desires the coöperation of the manufacturers, engineers and users of this material. You are invited to state just what tests should be included, in your opinion, and also to give suggestions as to the conduct of the tests.

Some of the points that naturally suggest themselves are as follows:

(1) What should be proposed as a standard tensile test?

(a) Proper length of specimen, taking account of that critical length over and above which the strands will act as a unit.

(b) Type of end sockets or connection.

(c) Elongation, etc.

(2) What importance do you attach to the torsion test? (Some authorities believe this to be superfluous) and what would you propose in the way of a standard test for torsion?

(3) Have you anything special to suggest in the way of cold bend test over the usual methods?

(4) So far as we have learned little has been published in the matter of impact tests. It would seem as if this field is very important and recommendations are desirable.

(5) What would you do in the matter of abrasive tests?

(6) Biggart, Stone and others have proposed and made tests in which the life of cables, and other properties, are investigated by passing them over a series of pulleys direct and reversed, the cables being subject to different direct tensions. What do you think of the relative value of such tests, and how should they be carried out?

(7) We have read papers where samples of cables have been taken under actual service conditions after a number of years' usage in mine or elevator service, and tests compared with the unused original material. Is anything in this line desirable?

(8) Are any other physical tests necessary?

(9) Chemical tests will be made. Have you anything to suggest in this respect?

(10) What number of duplicate tests would you suggest for any one type or specimen? Tetmajer used two in his tests. Three would seem more desirable. For the individual wires he used eleven. Would not a lesser number, say six, be sufficient?

In conclusion, we shall be very glad for an expression of opinion as to what portion of the above mentioned points as they relate to tests shall have weight, also to have you mention any other features that will naturally occur from your experience. In any future publications made, credit for individual ideas will be given as may be appropriate.

JNO. H. GRIFFITH,
For the Director of the
Bureau of Standards.
Pittsburgh, Penn., June 3, 1912.

An Engineering Concern of Broad Scope

Sir—I inclose for the edification of your readers a page advertisement abstracted from our telephone directory. You will note that the promoters of the gigantic combination there advertised not only include practically everything now and heretofore constructed by the hand of man, but also dip into the future, and see a merchant marine of reinforced-concrete leviathans and floating palaces.

What in the name of socialism are the rest of us going to do?

T. T. E.
San Francisco, Calif., June 4, 1912.

[We print the advertisement (without the display and omitting the names) below. We recall a previous case, years ago, where an engineering school graduate, young in years and experience, advertised as a consulting engineer and enumerated as his specialties a dozen different fields in engineering.—ED.]

If you have any good tidings or troubles, tell them to Blank & Blank. They can help you out with the designing and making drawings of municipal work, wharves, bridges, railroad and electric railway surveys; water-power plants, water supply and irrigation, land surveys; cement and concrete work, reinforced-concrete piles and bridges, sea walls, piers, towers, wharves, water and oil tanks, stand pipes, reservoirs, coffer dams and foundations; our specialty is reinforced concrete, large sea-going vessels, freight and passenger steamships, oil boats, barges and launches, floating wharves and dry docks; architectural and building construction work, modern steel structures, trusses, girders, columns, towers, stacks and tanks, elevated railroads, subways and tunnels; mechanical appliances, hydraulic and refrigerating marine and turbine machinery, derricks, hoisting apparatus and conveying machinery, cement and power plants, rolling mills and furnaces; miscellaneous, patent-office drawings, air ships and flying machines, general working drawings, details, plans and specifications, plaster houses and bungalows, landscapes, park and terrace layouts. Our object is to do the work right, so just tell us part of what you want and we will do the rest.

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Engineering News

The Locomotive Boiler Explosion at San Antonio

The locomotive was all but ready to leave the repair shops. Steam was raised and soon the safety valves opened. The steam gage in the cab showed only 50 lb. pressure. The employee assigned to this duty (of whose experience and judgment nothing was known by his superiors) screwed down the adjusting screws of the valves and waited for the pressure to rise. The steam-gage needle swung around to 150 lb. and then the valves opened again. But the working pressure for this locomotive was 200 lb. The question was how to tighten the adjusting screws, already tight down to the limit of their travel, even further, so as to bring that gage needle up to the mark. The employee, while not much versed in knowledge of safety valves, was a person of ingenuity. He obtained a pipe wrench, which would be able to grip the screw heads even now that their corners were rounded off by his previous efforts, and succeeded in jamming the screws down a little further. One of the screws had no lock nut to hold its head away from the top of the valve casing and was screwed down until the stem of the screw inside the casing was bent by compression, mutely testifying to the vigor though not the intelligence of the workman. He waited again for the pressure to rise. It did, with the effects described elsewhere in this issue.

It would be superfluous to make any comment on the imperfection of an organization which, even under stress of labor difficulties, would put a man of whose experience and judgment nothing was known in a position to endanger his own life and those of scores of his fellows. But this is not the whole of the story by any means. An examination of the wreck showed that the crown-sheet sling stays were the first elements of the boiler to give way under the excessive pressure. These stays, it appears, were of wrought iron instead of the steel specified, and in a number of cases they were held to the crown bars by 1-in. bolts instead of the 1¼-in. bolts called for by the drawings. Tests of the holding power of these stays fitted with 1-in. bolts showed a factor of safety of only 2.67.

It is not surprising, after this much is known, to learn that the Interstate Commerce Commission's rules governing the inspection of locomotive boilers were disregarded by the railway company's inspector and the other officials in charge of such work. Reports stating that the safety valves of this locomotive had been adjusted and the steam gage tested were sworn to by these officials some days before the accident, whereas the evidence brought out at the investigation shows that the safety valves were being adjusted at the time of the disaster and that the inspector was not present at the testing of the gage, although he certified under oath that this work had been done.

Under such conditions, it is hard to see the value of the additional locomotive inspection rules which are to be put into effect at the instance of the investigating committee. If it be impossible to do more than to somewhat sternly reprimand a railway company for such flagrant violations as these, what is the virtue of adding to rules which are already sufficiently comprehensive to insure safety?

The Contrast between Railway Employees' Wages in Europe and the United States

American engineers and railway men, traveling abroad, are amazed at the extraordinarily low rates of wages prevailing on European railways. Statistics on this matter have recently been collected by the Bureau of Railway Economics and are soon to be made public in its Bulletin No. 34. From an advance statement of the contents of this bulletin we take the following figures. In the year 1910 the average daily compensation of all classes of railway employees in the United States was $2.23. This compares with an average wage in the United Kingdom of Great Britain and Ireland of $1.05, in Prussia-Hesse of 81c. and in Austria of 89c. Comparing the average wages of employees engaged in locomotive operation, an English Board of Trade report gives the average weekly pay of engine runners in the United Kingdom in 1907 as $11.17 and of firemen as $6.67. In the same year the average weekly earnings of engine runners on American railways (counting six days to a week) was $25.80 and of firemen was $15.24. Since 1907, however, the wages of railway employees have been very much increased in the United States over the rates paid in 1907. The bulletin states that taking the report of two representative American railway companies, the annual compensation of engine men now ranges from $1100 in switching service to over $2800 in passenger service and of firemen from $700 in switching service to over $1700 in passenger service. Comparing this with the annual earnings of European locomotive crews, it is stated that the salaries and allowances of a German engine runner amounted in 1908, the last

year available, to $646.88, and of the firemen to $424.59. On two principal French railways in 1908 the annual earnings of engine runners ranged from $505 to $906, and of firemen $324 to $595.

It is of course true, however, that while the American gets much higher wages it costs him much more to live. The bulletin gives some interesting information on this point also. While rentals in Berlin, Paris or London are fully as high as the average in the United States, a three- or four-room house in England or on the Continent costs on the average $30 to $90 a year less rental abroad, outside of the metropolitan centers, than it would cost in the United States. The British Board of Trade estimates that the food and fuel taken as necessary for the consumption of a typical working-man's family costs in the United States 17.8% more than in France or Germany, 35.3% more than in Belgium and 38% more than in Great Britain. On the basis of these figures it appears that the average American railway employee has to deal with a cost of living less than 50% greater than his foreign brother, but receives more than double the wages.

It may well be asked how can American railway companies pay double the rates of wages to their employees and at the same time carry passengers for no higher fare and freight at a considerably lower rate than railways abroad? The answer to this question is that American methods of railway operation enable the railway business to be carried on with fewer employees than are used in Europe. The case is exactly similar to American manufacturing plants which pay higher wages to workmen and produce goods at a lower unit cost than foreign competitors. The present danger is that by such legislative interference as "full train crew" laws, American railways may be compelled to increase unnecessarily the number of their employees and thereby be rendered unable to pay the higher rates of wages which have always characterized their operation.

Securing Economy and Efficiency in the Federal Government Business

In view of the enormous amount of discussion in the public prints during the last two or three years regarding efficiency, it is decidedly interesting to learn that Congress is in doubt whether to appropriate the money to enable the Commission on Economy and Efficiency, appointed by President Taft, to continue its work.

It may be true that the present commission has not done all that it might have done and possibly it has been hampered by external pressure of one sort or another; but there can be no question whatever that there is no greater need in our governmental system than an overhauling of the system itself to find the causes which produce loss of efficiency and waste of the public funds. It is probably a fair guess to say that the United States treasury loses a thousand dollars every year from wasteful methods of doing work and from doing work which is not worth the doing for every dollar that it loses through graft, great or small.

There was recently brought to our attention one of the underlying causes which we are informed is responsible for an enormous loss to the government. The source of this loss is to be found—of all places in the world—in the Auditor's office of the Treasury Department, an office established for the direct purpose of preventing loss of the public funds. The treasury auditors maintain a large clerical force which is engaged in scrutinizing and checking the accounts turned in by the great number of disbursing officers in the various departments who are intrusted with government funds to expend. This is all proper enough and a very necessary check on extravagance and waste as well as graft.

It has long been a source of wonderment, however, to those who know something of governmental operations, why the auditor's office should interpose so many objections and queries, requiring a vast amount of correspondence, explanations, and arguments, before a bill perfectly correct and justifiable could be audited and paid. The explanation, however, is really a very simple one. It appears that the clerical force in the auditor's office is rated under Civil Service rules on the basis of the number of exceptions which each clerk takes to the accounts which he checks over. The more exceptions he can make, the higher his rating for efficiency and the better his chances for promotion. Where any such cast-iron basis exists for determining a man's ability, it is, of course, to be expected that each clerk will search each account laid before him with a microscope. Every i must be dotted and every t crossed; every voucher must be certified and sworn to and every loophole plugged tight.

This machine operates with wonderful efficiency to automatically destroy efficiency and initiative in every governmental department which has to do with the expenditure of money; and that means practically all government work. Of course, a government officer will not go out of his way to try something new and to adopt some new way of doing work. In the whole government force, the employees will miss trains and hold up contracts indefinitely if it is necessary to have every voucher properly certified and filled out and every chance of clerical error checked. Disbursing officers of experience in government service well understand that any attempt on their part to introduce greater efficiency in their force by using short-cuts or eliminating red tape is likely to bring them its reward in the shape of being obliged to pay Uncle Sam's bills out of their own private purse, not too plentifully replenished by the government's modest salary.

We earnestly hope that Congress will provide funds to continue the Commission on economy and efficiency. We earnestly hope also that this commission will be so constituted that it can investigate without fear or favor, and be able to remedy such grave abuses as that which we have just pointed out. We hope it will point out to Congress itself the absurdity of the statute which makes it a penitentiary offense to interfere with the government's system of bookkeeping, by which it is attempted to keep absolutely separate the expenditure of different fiscal years.

We may go further and say that the service of the federal government ought to be a service which would enlist the loyal and hearty enthusiasm of those engaged in it. That is an element of utmost importance in introducing real efficiency into the government departments. In order to gain such efficiency it is absolutely necessary that some of the hampering and dangerous coils of red tape shall be sheared away.

The Power Cost of Locomotive Draft

The paper in this issue by H. B. MacFarland, Engineer of Tests of the Atchison, Topeka & Santa Fé Ry., suggests the possibility of some radical changes in locomotive design. Mr. MacFarland raises and answers the question, "What does the back pressure in the locomotive cylinder, necessary to make the exhaust nozzle blow the fire, cost in the way of increased fuel consumption and reduction of power?" The figures he gives will surprise even those most familiar with the details of locomotive design.

It is doubtless a far cry from the facts recited by Mr. MacFarland to any such radical change in locomotive practice as a different method of furnishing draft than the exhaust nozzle. Nevertheless in the last 25 years changes even more radical than this have taken place in many fields of mechanical engineering. The possible saving and increase in available power held out by Mr. MacFarland's figures should set some ingenious designers at work trying to find a way to make the saving which he shows to be possible.

Mr. MacFarland's tests showed that on an ordinary locomotive at speeds of 20 to 35 miles per hour the actual power expended in moving the gases through the fuel bed on the grates and through the boiler tubes amounted to 25 hp. Under these conditions the loss of power

of the locomotive due to back pressure in the cylinders made necessary by the contracted exhaust nozzle was from 300 to 600 hp.

Astonishingly large as is the disparity shown by these figures, it simply bears out what is well known to mechanical engineers, that a steam jet is a most expensive and inefficient way of producing draft. Although steam-jet blowers have been used in small power plants to a limited extent ever since the early days of steam engineering, every engineer knows that their use is an expensive way to produce a draft. In all power plants of any considerable size where forced draft is in use, therefore, fans instead of steam jets are used.

It is fair to say, however, that a fan blower itself is not always a very efficient method of producing draft. The efficiency of the fan blower itself often ranges below 60% and the small steam engine commonly employed to drive it eats up an enormous volume of steam in proportion to its power.

Even if it were possible to use a fan to produce locomotive draft, the steam necessary to drive the fan would represent very much more than the theoretical horsepower of energy required to force the air through the fuel bed and the tubes and out of the stack. Upon a locomotive, however, there would be great difficulty in using a fan blower. In the first place there is scant room for such a device with its propelling machinery at either the front end or the rear end of the boiler. In the second place it would probably be necessary to have any draft-producing device at the front of the boiler; but the impossibility of carrying the hot flue gases through any moving machinery will be manifest.

About the only system that suggests itself as a substitute for the present steam-jet action of the exhaust would be to carry an air compressor on the locomotive and discharge a jet of high pressure compressed air in the center of the stack, thus inducing a draft through the flues. It is quite possible, of course, that this method of draft production would be little if any more efficient than the present method in which the exhaust steam is used. There is merely the chance that the use of air at high pressure, say 70 to 100 lb. per sq.in., instead of the exhaust steam which is at a pressure of probably only 8 to 12 lb. on the average, would give a higher efficiency.

Among other possible ways of producing draft may be mentioned the closed ash pit, already in more or less use where forced draft is installed on marine boilers. It would be impossible to use this with a hand-fired locomotive, however, since a blast of flame would be forced out of the fire-door every time it was opened. It would be necessary to adopt some form of mechanical stoker which would not permit the escape of air from the firebox space through the entering stream of fuel.

Perhaps the most hopeful direction in which to apply Mr. MacFarland's deductions to the improvement of locomotive design, is to search for some method by which the exhaust from the cylinders may be made more efficient in the production of draft. In other words, it is entirely within the possibility that a draft sufficient to produce the present high rates of combustion on the grate might be produced with much less back pressure in the propelling cylinders than is now required.

One of the most obvious possibilities of improvement would be to alter the design of the locomotive front end so as to facilitate instead of obstruct the smooth and regular flow of the gases through it. Mechanical engineers know perfectly well that in order to design either a water turbine or a steam turbine so that the working fluid shall pass through it with the greatest efficiency in power production, the lines of stream flow must be smooth and regular so that the energy of the moving fluid shall not expend itself in eddy currents. The interior of a locomotive front end, however, has never had anything but rule of thumb study and pretty crude thumbs at that. The sole object of those who have tinkered with the front end and the stack has been to make the locomotive steam well and distribute the draft evenly over the grate. Very little attention has been paid to the problem of permitting the largest possible exhaust nozzle so as to reduce back pressure in the cylinders. Inventors in plenty have schemed out sharp prows for locomotives to reduce the air resistance on the train, but we know of no inventor who has designed an interior fitting to the front end of the locomotive which would enable the gases to pass smoothly from the tubes to the stack. Yet the velocity of these gases is many times that of the air moving past the side of a high-speed locomotive.

There are also possibilities in the use of an exhaust nozzle of different form, which would expose a larger surface to the moving gases and thereby entrain them and draw them along up the stack with less frictional loss. In steam-jet blowers, for example, it has been found that greater efficiency is produced by a ring of small jets than by a single jet discharging an equal quantity of steam. It would be possible to make an exhaust nozzle of star-shaped form, for example, and thereby secure a greater entraining action upon the gases.

Still another direction in which Mr. MacFarland's tests are very suggestive is as to the advantage of increasing locomotive power by increase in the size of grates and in the available cross-section for the flow of gases through the flues rather than by the use of excessive draft pressures. Mr. MacFarland's tests establish clearly that for high-speed work in particular the loss in power through the increase in back pressure nearly counterbalances the increased capacity due to high rate of fuel consumption on the grate. When one adds to this the well known excessive loss of fuel in solid particles out of the stack as the result of high draft pressures, the lesson to the locomotive designer is so plain that he who runs may read.

The Automobile and the Open Drawbridge

The automobile, with its relatively high speed and often inexperienced and reckless driver, introduces new problems in the question of making safe our highways. The automobile tourist covers distances hitherto impracticable for private vehicles and necessarily traverses many roads and city streets with which he is entirely unfamiliar. He is therefore apt to succumb to dangers of the road which would be readily avoided by a driver at home in the district.

It is fruitless to say that any really cautious person will drive slowly on unfamiliar roads and that the reckless deserve their fate. For the fact remains that the majority of motor-car drivers are not of the over-cautious type —and what about the innocent passengers who have nothing to do with driving the car and perhaps little knowledge of the possible dangers?

The motor tourist in strange districts requires warning signs or signals to protect him from dangers that are perfectly obvious to the native. The high speed of the motor car requires that these signs or signals be of such a nature as to be perceived at a good distance before the danger point. These needs have been recognized in some localities, for example, by the placing of warning signs at a distance of 200 ft. or more on each side of dangerous railway crossings or sharp curves in the highway.

Another place where such signs would be of use is on the approaches of drawbridges. Recently five persons were drowned in Chicago in an automobile which ran at high speed onto the approach of a swing bridge when the draw was open. The accident points toward the advantage of the double-bascule type of drawbridge, where the moving spans, when open, act as barriers across the roadway, as well as signals which cannot possibly be mistaken.

A decade or two ago there was much talk of drawbridge gates. The subject soon dropped out of sight; now it may well come to the front again, with the high-speed automobile as its present concern. Warning signals alone, whether signboards or the railway-crossing type of barrier, are likely to prove less effective than strong gates.

Blowout of a Canal Retaining-Wall at Ansonia, Conn.

On May 28, 1912, a retaining-wall in the bank of a power canal of the Ansonia Brass & Copper Co. (branch of the American Brass Co.) at Ansonia, Conn., failed by undermining. The break quickly emptied the power canal and the associated reservoir. A large quantity of water flooded the mill yard of the Ansonia Brass & Copper Co. and did considerable damage there and in the town below.

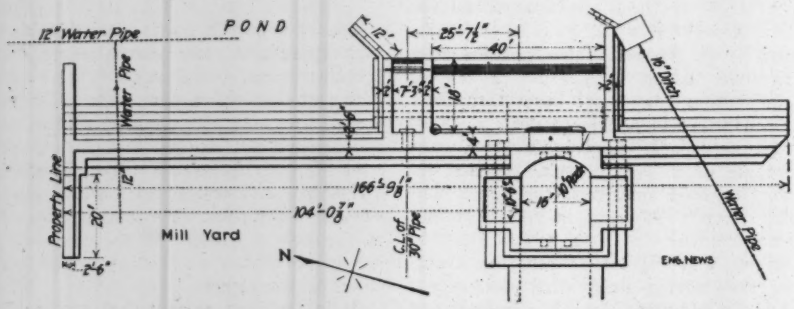

FIG. 1. PLAN OF POWER-CANAL WALL, ANSONIA BRASS & COPPER CO., ANSONIA, CONN.

The accident is of unusual nature and the account of the circumstances is interesting. The facts have been given us quite fully by J. R. Coe, Chief Engineer, American Brass Co., Waterbury, Conn., who built the wall last year. The photographs Figs. 8 to 11 herewith may be referred to as showing the nature of the accident, and Figs. 6 and 7 will show the appearance of the retaining-wall before the failure. The wall and its associated features are shown more precisely in the drawings Figs. 1 to 3.

The plan of the wall, Fig. 1, shows the wall itself, the intake on the water side for two penstocks, and the main wheelpit back of the wall, fed from the large penstock. This wheelpit extends a considerable distance below the foundation of the wall itself. The sections in Fig. 3 show the relation of wheelpit and wall more clearly. Beyond the intake the wall is of the construction given by Fig. 2; it is a plain retaining-wall, 26 to 29 ft. high above foundation, retaining about 25 ft. of water. On the land side the toe is covered 6 to 9 ft. deep; on the water side the inner half of the original canal bank lay against the wall. The dotted lines in Fig. 2 show the profile of the original bank, while the full lines show the profile after the wall was built.

The canal, built in 1845, follows along the hillside from a dam in the Naugatuck River about 1½ miles above Ansonia to the point where the mills are located, just below the town; here a natural basin was developed into a forebay by the west embankment of the canal. A 40-acre storage reservoir is located about halfway between the dam and the forebay. The available head, corresponding to the natural fall of the river, is about 30 ft. Water level in the forebay is about 18 ft. above the mill yard of the Ansonia Brass & Copper Co., which in turn is several feet above the level of the main street, west of the yard. Apparently no change was made in the embankment or canal at this point from the construction of the work until last year.

About two years ago two old waterwheels in the copper mill, which were of obsolete type, and the old wooden penstocks supplying them, which were in bad condition, were removed and plans were made to build a new intake and wheelpit for larger horizontal turbines of modern type, together with a retaining-wall to replace the bank. The wall, intake and wheelpit were built late last year, according to the plan Fig. 1 and the section

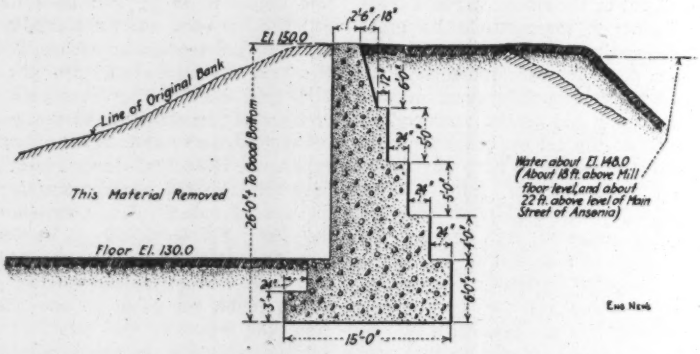
El. 150.0
Line of Original Bank
This Material Removed
26'-0" to Good Bottom
Floor El. 130.0
Water about El. 148.0 (About 18 ft. above Mill floor level, and about 22 ft. above level of Main Street of Ansonia)
ENG. NEWS

FIG. 2. SECTION OF WALL, AND ORIGINAL EMBANKMENT SECTION; ANSONIA BRASS & COPPER CO.

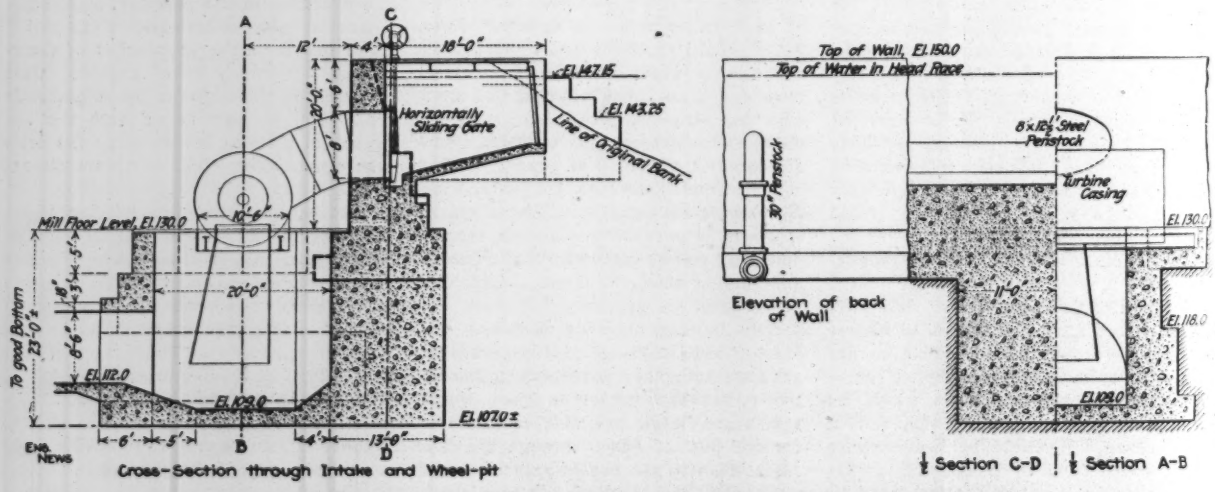

FIG. 3. SECTIONS AT INTAKE AND WHEEL-PIT, ANSONIA BRASS & COPPER CO.

Figs. 2 and 3. The last of the work was completed early in 1912.

In planning the wall the old canal bank was relied upon as furnishing a thoroughly good water seal. Since the original construction of the canal the bank had been to all appearances absolutely tight, with the exception of a washout 28 years ago which was caused by the failure of a cofferdam used in repairing one of the intakes. The subsoil under the embankment is gravel, but the inner portion of the canal bank and the bottom of the canal were covered with a layer of silt which formed an impervious layer. The design of the new work was made with the idea of providing a wall to resist the thrust of the pressure of water and earth while relying on the inner half of the embankment with its silt lining for watertightness.

The wall is 20 ft. high from mill-yard level to crown, or 26 to 29 ft. high above foundation. The water face for its full height, and the land face below yard level, are stepped as shown in Fig. 2. The wheelpit has a depth of some 23 ft. below mill-yard level or about 15 ft. below the level of the wall foundation. The walls of the intake, on the water side of the wall opposite the wheelpit, were connected by a floor of concrete sloping up from the bottom of the penstock to meet the canal bank, as is best shown by the transverse section in Fig. 3.

The method of construction used was to build the new wheelpit and its tailrace connection before the embankment was seriously disturbed or any work started on the new retaining-wall (see Fig. 5, showing the wheelpit excavation with the embankment practically undisturbed). The wheelpit excavation was carried through clean gravel, whose dry condition showed that no water entered it from the canal; in other words, the silt on bottom and sides of the canal proved a complete seal.

The wall was built after the wheelpit was constructed. A bag dam was built in the canal some distance north of the new intake and water for mill purposes was carried down by a temporary pipe line; the forebay was practically emptied. A line of sheeting was driven in the old bank to the depth of the foundation level of the new wall. The excavation for the wall was then made and the wall concreted. The bottom was sound gravel. The depth of 6 ft. shown in the drawings is the minimum depth of foundation, excavation being carried lower where necessary to reach sound bottom. This fact, together with the manner of failure of the wall, gives every reason to believe that the foundation was satisfactory for the load it had to carry.

Backfill behind the wall was made of selected material, puddled and tamped into place. The material of the landward half of the embankment was used to reinforce the bank on the water side throughout the length of the new wall and for some distance north.

The circumstances of the blowout are described by Mr. Coe as follows:

> On May 28, 1912, at 3:10 p.m., water was noted coming up through the ground, between the wheelpit and the mill supply pipe shown on photograph (see Figs. 6 and 7), by a mason employed nearby. This man immediately sounded an alarm which withdrew all workmen from the mills and caused gates to be closed in the canal about three-quarters of a mile north of the new intake. The amount of water flowing through the hole increased very rapidly and within five minutes the mill yard was flooded to a depth of about 2 ft., the water flowing through the mill yard to the main street and the river. Approximately 20,000,000 gal. of water flowed through the hole under the wall in two hours' time, carrying with it a considerable portion of the old canal bank, undermining the intake walls and floor, which fell.

The views Figs. 8 to 11 show the wall at the break on the next day, May 29. The appearance of the wall is quite in harmony with the description given above. The washout evidently occurred just under the intake, and apparently along the north side of the wheelpit, near the 30-in. pipe. From the view Fig. 7 it will be noted that this pipe passes down from an inlet opening in the retaining-wall just north of the wheelpit, and (Fig. 9) turns horizontally toward the mill just about at wall-foundation level.

The two views Figs. 10 and 11, taken from the bed of the canal and looking toward the wall at the point of failure, indicate the location of the hole under the wall and the general dropping of material and breaking of concrete in a direction toward that hole. The appearances in every way indicate that water found its way through the foundation layer under the wall near the point of junction of wall and wheelpit and here washed out a hole large enough to pass water in great volume in a very short time.

The point of failure is somewhat different from other parts of the wall foundation in the special conditions occurring at the junction of wall and wheelpit. While the wheelpit and the wall rested on undisturbed bottom, a small amount of fill was placed at their junction, under

FIG. 4. OLD EMBANKMENT; LOOKING NORTH

FIG. 5. EXCAVATING FOR WHEELPIT, IN GRAVEL; LOOKING EAST TOWARD EMBANKMENT

FIG. 6. NEW WALL AND INTAKE; LOOKING NORTH

FIGS. 4-7. OLD CANAL EMBANKMENT, AND WALL WHICH REPLACED EMBANKMENT; ANSONIA BRASS & COPPER CO.

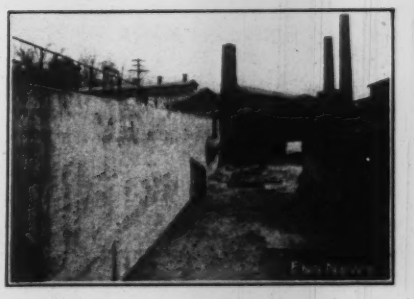

FIG. 7. OUTER FACE OF NEW WALL; LOOKING SOUTH

the bottom of the wall. Mr. Coe states, in answer to a query:

> The method of construction was such as to produce a small vein of filled-in material in the angle between the bottom of wall footing and the wheelpit wall. This backfilling was made of carefully selected material, thoroughly puddled and tamped in place.

Whether this is to be connected with the failure is, of course, conjectural. The entire design presupposed the tightness of the canal lining. This lining, interrupted by the walls and floor of the intake, appears to have given passage to water and thus produced leakage through the soil under the wall.

The work involved in this accident was designed by the engineering department of the American Brass Co., J. R. Coe, Chief Engineer. The plans were passed upon and approved by John H. Cook, of Paterson, N. J., who, however, had no connection with supervising the execution of the work. The contractor was Fred T. Ley & Co., Inc., of Springfield, Mass.

The present plans for protecting the bank against similar undermining in the future involve driving a line of interlocking sheet-piling from the top of the canal bank to a depth at least 20 ft. below yard level, or 40 ft. below top of wall, and embedding the sheet-piling in the concrete of the retaining-wall and intake walls. This line of sheeting would be carried along the whole length of the wall and south along the forebay to the natural cliff, to form a complete cutoff for the southerly end of the forebay pond.

FIG. 8. BLOWOUT SEEN FROM ABOVE; LOOKING NORTH

FIG. 9. VIEW AT OUTER TOE, JUST NORTH OF WHEEL-PIT

Annual Convention of the Master Car Builders' Association

The forty-sixth annual convention of the Master Car Builders' Association was held on Young's Million Dollar Pier at Atlantic City, N. J., June 12-14, 1912. Superficially the most noticeable thing about the convention was the change this year inaugurated in the matter of entertainments by the Railway Supply Manufacturers' Association, which provides the very large exhibition of railway machinery and equipment that has become a most valuable feature of this convention and that of the Master Mechanics' Association which follows. Heretofore the railway officers attending the convention have paid their own dues and hotel expenses, but have accepted from the supply men as a body a number of favors in the way of formal balls, entertainments, and free rolling chairs on the board walk. This year the railway men decided not to continue the old arrangement, but to simplify all the formal entertainment and to divide all the expenses of what general entertainment there was equally between the two railway associations and the manufacturers' association.

The change, however, was not very noticeable, at least on the surface. Instead of a formal "Master Car Builders' Ball" there was an "informal dance," but to the disinterested observer the name was about the only difference in the two. There were not as many men reclining luxuriously in free rolling chairs and no regrets over the loss by a single point at bridge of the beautiful cut-glass pitcher or leather traveling bag offered as prizes; but in the main there was little concern on the part of the railway men and some considerable complaint by the supply men that the absence of formal entertainment made it more difficult to find the men they wanted to see.

As usual the most important duties of the convention were the discussion of the reports of the Arbitration Committee which settles disputes in regard to the interchange of freight cars and the acceptance, after discussion, of the revisions in the rules of interchange and the standards in the design of those cars. With the exception of one paper the entire proceedings were discussions of committee reports, the more important of which are abstracted below.

COMMITTEE REPORTS

SAFETY APPLIANCES—The chairman reported that the committee are still in con-

FIG. 10. INTAKE AFTER FAILURE; LOOKING WEST FROM CANAL; DIVIDING WALL TO 30-IN. PIPE AT RIGHT

FIG. 11. VIEW JUST NORTH OF FIG. 10

FIGS. 8-11. WALL AND INTAKE AFTER BLOWOUT; ANSONIA BRASS & COPPER CO.

ference with the authorities executing the federal safety-appliance act, and that no work other than that is being done. Certain proposed changes in the rules of interchange brought about by the federal law were reported to the Executive Committee for action.

CONSOLIDATION—The proposed consolidation of this association with the Master Mechanics' Association is not now active, the committee reporting no work at all during the past year.

CAR UNLOADING MACHINERY — The Committee on Rules for Loading Material has been investigating the damage to freight-car equipment by the various types of unloading machines used to dump the entire contents of the car, generally ore or coal, but occasionally quarry stone, and reported upon the subject at this convention. It finds that there are a great number of such machines in use, but that they are all alike in imposing breaking strains upon portions of the cars they unload. The Pennsylvania R.R. has found, for instance, that 95% of their cars were damaged in one way or another as they were handled through the machines, and that further the safety appliances were damaged on something like 32% of the cars. The committee concluded that the damage to the car bodies and to the safety appliances was the result of improper location of the application points of the cradles of the unloading machines against the car to be unloaded. It has, therefore, requested all makers of the unloaders to send in drawings of their machines, from which a composite drawing is to be prepared and applied to various types of cars, with a view of devising a standard general type that will cause least injury to the equipment. Such a study is to be carried out during the ensuing year.

OVERHEAD INSPECTION OF BOX CARS—The report upon this subject by the Committee on Rules for Loading Material provoked one of the longest and most active discussions of the convention. The initiation of the investigation resulting in this report is to be found in the enormous total amount of claims brought against railways by shippers on account of damage to freight from insecure, incomplete or damaged cars. Quoting from the report:

> From 1900 to 1910 the payment by the railroads for freight loss and damage per annum has increased in the United States from $7,055,622 to $21,756,671.* These figures do not include the enormous clerical expense involved in the investigation and handling of claims. Furthermore, it is estimated that the unreckoned inconvenience and loss of time, by the public, incident to these failures of transportation, represents another loss about as great.
>
> Inquiries to some of the larger systems asking for amount of claims paid on account of defective equipment covering the month of November, 1911, result in the following:

Total mileage of roads reporting	82,360
Gross earnings	$111,004,783.00
Claims paid:	
Account of leaky cars	22,228.10
Defective cars leaking contents	19,919.89
Projecting nails, etc.	529.08
Dirty cars	1,625.61
Other causes	1,341.37
Total claims paid as above	59,650.15

The committee concluded that these losses are partly unavoidable, but that most of them could be corrected if a more thorough inspection of the car bodies were maintained. It suggested that there are two possible avenues through which an improvement may be directly approached, viz.: (1) concentrate the responsibility for losses due to defective car bodies in such a manner as to provide an automatic incentive for the use of better cars; and (2), establish standard requirements for the inspection of car bodies. As a start toward correcting the evil, the committee recommended that there be adopted standard rules for the inspection of car bodies similar to those for the inspection of safety appliances now maintained by the Interstate Commerce Commission. These rules propose that all box-car freight shall be classified in one of three grades, viz.: freight badly damaged by moisture, freight not readily damaged by moisture and rough freight. Cars would then be selected for the respective grades. Furthermore, all cars should be inspected for structural defects, such as cracks, broken boards, protruding nails, holes in roofing and tight and burglar-proof doors.

This report seemed to make a direct appeal to the members. One after another arose to testify to the deplorable condition of the overhead structure in the freight-car equipment today and to express the hope that some procedure could be devised whereby this equipment could be improved and the losses therefrom reduced. The causes of the condition seem to reduce themselves to two: carelessness as to overhead construction lasting over from the boom days of 1905-6, when freight cars were so much in demand that the railways could not leave them in the shops long enough for sufficient repair, and a reluctance on the part of the management to allow sufficient funds to the car-repair departments.

There was some discussion as to the ways and means of providing the proposed car-body inspectors, but the convention finally passed a resolution recommending that the Executive Committee prepare a statement of the conditions brought forward and submit it to the managers of the railways with a request for action toward relieving those conditions. It should be understood that none of this discussion applied to the running portions of a car or to the safety appliances, but only to defects which result in damaged or stolen freight with consequent loss by claims against the railway.

RULES FOR LOADING MATERIAL—In addition to the two above reports the committee which presented them submitted certain detailed changes in the rules for loading material which are among the standards of the Association.

COUPLER AND DRAFT EQUIPMENT—For many years the Master Car Builders' Association has had a frequently revised specification for couplers, which specified certain dimensions and provided certain tests which an acceptable coupler should fulfill. Acting under this specification a number of companies have been manufacturing couplers, all satisfactory but all differing in many details. As a result there is a great variety of couplers in use, all differing slightly from each other, and each railway must keep in stock for repair purposes all of the couplers in use. Last year the Association, recognizing the desirability of complete standardization of coupler design, ordered the coupler committee to proceed with the design of a standard M. C. B. coupler.

The committee has been most industrious during the year, but on account of the magnitude of the task it could only report progress at this year's convention.

Briefly its work to date has comprised: An investigation of the general contour of the present standard, which resulted in the recommendation of some changes; studies of the behavior of couplers in service and under test; and several conferences with coupler manufacturers to ascertain possible methods of caring for patent difficulties should the committee wish to embody in its standard coupler any points covered by patents. As a result of this work the committee reports that its studies are in a very satisfactory condition, but that it is not yet ready to present the desired standard.

TRAIN-LIGHTING EQUIPMENT—The standards for train-lighting equipment submitted *in toto* to the letter ballot of the Association last year were not adopted, and the committee this year re-drafted them and they were accepted by the convention to be sent to letter ballot by separate item so that some definite result could be reached as to which parts were and were not acceptable to the Association.

SPRINGS FOR FREIGHT-CAR TRUCKS—The committee on this subject stated that while springs now in use as a rule take a permanent set, have too little range of deflection and sometimes break in service, the manufacturers are carrying on extensive tests into the nature of the metal required, which promise relief from those evils. It therefore recommended that at present no definite action toward standard specifications be made.

TRAIN-BRAKE AND SIGNAL EQUIPMENT—This committee submitted a number of minor revisions in its standards and one rather important one which provided for a signal-hose coupling of the same con-

*Including loss due to wrecks, only a few of which may be charged to defective overhead car equipment.

tour, but in reverse of the brake-hose coupling, the intention being to avoid the somewhat common mistake of coupling a worn signal-hose coupling to a brake-hose opposite coupling and thus throwing one or the other lines out of use back of that coupling point. The report was accepted and sent to letter ballot.

TESTS OF BRAKE SHOES—The committee's report was in two parts, one on brake shoes and the other on brake beams. In the first part the recommendation was made that the shoes tested last year at a speed of 80 miles per hour and under pressure of 12,000 to 20,000 lb. be tested at a speed of 65 miles per hour under the same pressures. This is the same recommendation that was made last year, but the Executive Committee did not see fit to advance the funds for the purpose.

The committee recommended several minor changes in the brake-beam standards and reported for use, with a view toward its adoption as "recommended practice" a No. 2 (15,000 lb.) standard brake-beam. This beam was designed mainly as the result of a number of tests carried on during the past year. In the discussion several members stated that the standard brake-beams were of such length (60¼ in.) that there was often a slight overhang of the brake-shoe on the wheel, resulting in uneven and rapid wear of the shoe. It was therefore suggested that the Committee consider the reduction of the length. With this exception the report was accepted and sent to letter ballot, although a motion was put and lost to withhold for further study the acceptance of the No. 2 standard beam as "recommended practice."

CAR WHEELS—The standing committee on this subject had referred to it by the Executive Committee the following principal instructions: Prepare specifications and physical tests for cast-steel, rolled-steel, forged-and-rolled-steel and forged-steel wheels; prepare drawings showing principal dimensions of the same types of wheels; and prepare drawings showing a standard method of fastening for built-up steel-tired wheels.

In the study of the steel-wheel question the committee conferred with representatives of the manufacturers and examined the already prepared specifications of the joint committee of the wheel manufacturers and the American Society for Testing Materials. While submitting these last-named specifications to the Association (with some changes as regards tolerances) the committee made the following comment upon them:

> After a careful study of these specifications, as well as those furnished by various railway companies, together with observations of wheels in service, your committee has come to the conclusion that the art of manufacturing solid steel wheels is yet in a process of development. There are a number of questions relating to the chemical and physical properties of carbon and alloy steel, and method of treating and handling the steel in its process of manufacturing that are now being investigated.
>
> On this account, your committee has thought it unwise to recommend a standard specification at this time, governing the quality of the material or the method of manufacturing solid steel wheels, and has only recommended the adoption of a specification governing the maximum variations that will be allowed in the fabrication of new wheels.

This recommended specification applies to both passenger and freight-car wheels. Cast-steel, one-rim wheels were not taken up.

A tire for steel-tired wheels, in which the fastening is accomplished by both bolts and shrinkage, was submitted as "recommended practice." The question of tests of solid steel wheels was considered to be still in process of development and no recommendations made.

In the revision of the specifications for chilled cast-iron wheels the committee recommended three out of nine changes suggested by the manufacturers. These involve the rejection of a lot by the failure under test of specimens of the same tape length only. The committee further states that a suggested 140,000-lb. capacity wheel is not necessary and that a proposed increase in flange thickness must be submitted to the American Railway Engineering Association, as it involves clearances of frogs, switches, etc.

The report was accepted and sent to letter ballot.

STEAM-HEAT PIPE AND CONNECTIONS—This Committee submitted certain details of steam-heat connections to be passed from "recommended practice" to "standard," and certain others to be passed as "recommended practice." They all were accepted without comment by the convention except a proposed specification for the testing of steam-heat hose, which came in for very severe criticism by C. D. Young (Engineer of Tests, Penn. R.R.). The Committee did not defend its specifications except to say that they were the best it could devise with the limited expert assistance available. However, as it was the opinion of the convention that the specifications, incomplete as they were, would produce a better steam-heat hose than the very poor product now generally accepted, the specifications was allowed to go to letter ballot for "recommended practice" with instructions to the committee to attempt an improvement next year.

TANK CARS — This committee presented complete specifications for ordinary tank cars, old tank cars having wooden underframes, special tank cars for transportation of liquefied petroleum gas ("casing head naptha") and a special tank car for transportation of liquid chlorine gas. The first two of these are revisions of old standards, with slight changes in the design of discharge and safety valves. The third (for casing head naptha "cars") specifies the design of a car to carry a new petroleum product which shows a high vapor tension at ordinary transportation temperatures, and therefore demands a safety valve of higher escaping pressure than that used for the ordinary petroleum products. The design of this valve, for 20-lb. escape, was made as the result of a number of tests described in the committee's report. A special valve was also designed for the liquefied chlorine-gas cars so connected to a metallic fuse that it will operate only when exposed to high temperature. This is necessary because the gas is very offensive and corrosive and of such vapor tension that it will only reach dangerous limits under the high temperature of a fire.

The report was passed to letter ballot for acceptance of the various specifications as standard.

TRUCK SIDES AND BOLSTERS—The Committee on Specifications for Freight Car Truck Sides and Freight Car Truck Bolsters presented tentative specifications for each, based mainly on reports as the nature of the cast-steel used by the various railways in these members and on some limited tests conducted by the Pennsylvania R.R. It recommends that there be sufficient funds provided for the testing of such trucksides and bolsters and for their design by a proper committee. The report was passed to letter ballot.

OTHER COMMITTEES—No definite reports were received from the following Committees: Car Trucks, Capacity Marking of Cars and Lettering Cars.

INDIVIDUAL PAPER

A paper entitled "Car Shop Apprentices" was read by I. S. Downing (Master Car Builder, L. S. & M. S. Ry.). His main argument was that there is great difficulty in recruiting employees in the car-building service because, first, of the specialization which car building demands and, second, because of the small hope of advancement in that service. The apprentices are generally started and continued in one highly specialized branch or trade, such as car-seat upholstering, or tinning, painting, cabinet making, all of which have a peculiar application in car building not valuable in outside practice of the same trades, so in consequence the boys have to continue in car building. It is very rarely that in that line they can reach a much higher position than foreman, whereas in the motive-power department they may become trained machinists available for employment in any machine shop or possibly may rise to the highest offices in the department. Consequently, the car department, as a rule, has the left-overs from the other branch of the service to draw from.

As a measure of relief, Mr. Downing proposed that the car-department men should have a line of promotion through the transportation department, which

would add an incentive to those apprentices who think that far ahead.

The paper was accompanied by a number of sample problems put before the car apprentices of the New York Central Lines.

The paper brought forth a lively discussion mainly from the old car men, who rose to the defense of the usefulness and importance of their branch of the service and to express the wish that the higher officials should do something to make it more attractive to the younger men. Among the suggestions was one that the apprentice be led through all branches of the car department so that at the end of his term he would not be a specialized mechanic, but a broadly trained car builder in the best sense of the term. In effect the arguments were that the men did not get sufficient present pay or future inducements to make it worth while for the sort of men that were needed. Relief seems to be in the hands of the managing officers of the railways.

OFFICERS

C. E. Fuller (Assistant General Manager, Union Pacific R.R.) was elected president for the ensuing year, with M. K. Barnum (General Supt. Motive Power, Illinois Central R.R.), D. F. Crawford (General Supt. Motive Power, Penn. Lines) and D. R. MacBain (Supt. Motive Power, Lake Shore & Michigan Southern Ry.) as vice-presidents. The secretary of the Association is Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

Proposed Improvements in the Building Department at Chicago

In developing efficiency of municipal administration one of the important but difficult problems is to secure the preparation and passage of a good building ordinance and code, but a still more difficult problem is to insure the enforcement of the provisions of such an ordinance "without fear or favor." In many cases this department is weak partly from failure to realize its wide scope of action and its importance to public health and safety; and partly from the many opportunities for improper influence or interference for personal or private advantage, to the disadvantage of the city and the public. Within the past two or three years, the municipal departments of Chicago have been investigated by impartial and expert authority in an attempt to increase their efficiency and to eliminate features of graft and dishonesty. In December, 1911, the Commissioner of Buildings (Henry Ericsson) requested the Civil Service Commission to investigate the organization and methods of the Department of Buildings. The report of the results of this investigation was presented early in June, and through the courtesy of J. L. Jacobs, of the Efficiency Division of the Civil Service Commission, we have been furnished with a copy of the report in advance of its general publication in printed form.

The report opens with a statement showing that the duties and obligations of this department are of a broad and comprehensive character, and its power for good or evil exceeds that of any other department of municipal government (except the police department). Its work directly or indirectly affects every inhabitant and enters into the commercial and domestic life of the city. The tremendous growth of the department, lax administration, ulterior influences, lack of trained and reliable employees, incorrect lines of organization, and greed on the part of builders and graft on the part of employees have all had their part not only in bringing about a demoralization of the department, but in adding to the difficulty of discovering faults and abuses and in ascertaining and applying the necessary corrective measures.

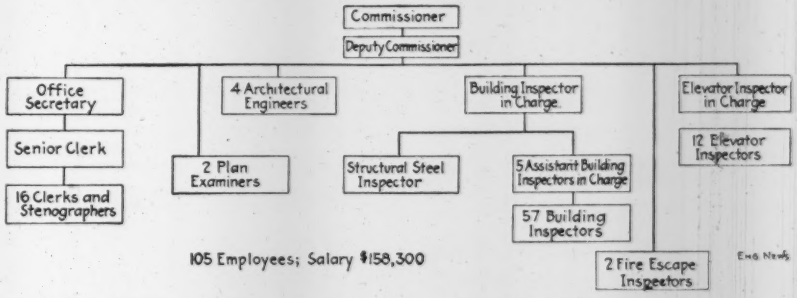

FIG. 1. PRESENT SYSTEM OF ORGANIZATION OF THE DEPARTMENT OF BUILDINGS; CHICAGO

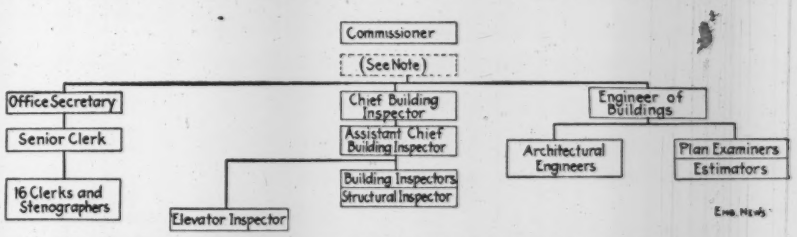

FIG. 2. ORGANIZATION OF THE DEPARTMENT OF BUILDINGS (CHICAGO) AS PROPOSED BY THE CIVIL SERVICE COMMISSION

(Note—The Chief Building Inspector would act as Commissioner in the absence of the latter, and the Engineer of Buildings would act as Commissioner in the absence of both of these officials.)

Under the building ordinances passed Dec. 5, 1910 (and amended up to Jan. 1, 1912), there was created a department for enforcing all ordinances relating to the construction, alteration, repair, removal and safety of all buildings within the city. The report states that the building code is perhaps the strongest and most detailed of its kind in this country. The activities of the department may be classified as follows: 1, examination of plans and specifications for new buildings and alterations; 2, field inspection (A, buildings under construction and alteration; B, fire escapes; C, new and old elevators; D, billboards and illuminated roof signs; E, annual inspection of existing structures); 3, records and permits.

The number of new buildings erected in 1911 was 11,106, with an aggregate valuation of $105,269,700; in 1910 the number was 11,409 and the valuation $96,932,700. During the past six years the annual average has been about 11,000 buildings and $100,000,000 valuation. The total appropriation for personal services of the department for 1912 was $158,300, and $100,200 (or 63% of the amount) is for salaries of inspectors. The total revenue for 1911 was $155,688, of which $110,793 (or 71%) was derived from permits issued for new buildings. These figures indicate the extent and importance of the work of the department.

In the investigation conducted by the commission, violations of the building ordinances were found without difficulty, and other evidence was secured definitely proving incompetence, negligence and graft. It was found that there were no permanent records of inspections, and that the methods of making and filing reports were loose in the extreme. For the work of this department the city is divided into four divisions (each under an assistant building inspector) and 30 districts, each under an inspector. The appropriation bill for 1912 provides for 57 inspectors, 27 of these being assigned to special inspection of billboards and signs and the annual

inspection of old structures. With this system of districting there is very unequal distribution of the work of inspection. For instance, a summary of the number of buildings in progress on a given date shows one district with 23 brick and no frame buildings, another with 328 brick and 8 frame, and another with 199 brick and 10 frame buildings. But the Commission states that in no case had an inspector too much work or too large a field. The inevitable converse is that many of them had too little work, so that great improvement could be effected by a better arrangement of districts. The reports made by inspectors are often unsatisfactory, and in several cases were found to be false, especially where violations of the ordinances were afterward detected.

The investigation disclosed the fact that in many cases plans were changed and the marks of the department stamp also changed. In some cases it was clearly shown that two separate sets of plans were kept; one in accordance with the ordinance, and the other (for actual use) not in accordance with it. In 500 buildings, 1800 violations were found. Many of these were in residences, flats and small theaters in residence districts. To remedy these conditions while imposing the least amount of hardship on innocent owners, the report suggests that the cases should be submitted to a committee composed of the commissioner of buildings, the commissioner of health, and an outside engineer.

The plans often show the buildings too large for the lot; that is, with less open spaces for passageways then the ordinance requires, and it is suggested that foundation plans should be required to indicate the exact position of the lot lines. The investigation leads to the conclusion that in most cases the architect knew that his plans violated the ordinance, but took it for granted he could pass them through the building department or the sanitary bureau. Where he does not superintend the construction, and violations are detected, the cost of changing the plan and work does not fall upon him, but upon the owner.

As to fire escapes it is recommended that the position of fire-escape inspector be abolished and the work done by the regular inspectors in connection with their other work. For elevator inspection there are 13 men, and their work is done more effectively than the building inspection, the main cause of inefficiency being lack of special training or experience on the part of the men.

In regard to the examination of plans, the owner submits these to the department to be checked by the plan examiner. They are sent to the architectural engineer only when structural details or strength of parts are to be checked; rarely are the specifications submitted to the examiner or engineer, although the ordinance requires this to be done. It is not possible for the present force of engineers to check thoroughly the plans and specifications of all buildings, and they have adopted the practice of accepting the plans of certain architects without much question. Only in cases of special doubt do they make particular study of the details. For the first three months of 1912, the three architectural engineers, besides being called upon for special engineering work, examined and studied the structural details of about 300 high-grade buildings, investigated the construction and stresses of 75 floors, and made special investigation of about 20 concrete foundations. The Commission points out that if the plans and specifications are to be examined and checked as thoroughly as required by the ordinances, there should be a sufficient number of highly-trained engineers and an engineer in charge of all work of this kind. The salary for this latter engineer should be at least $3000, and to him should report the architectural engineers, estimators and plan examiners.

Regarding the frequent action of the City Council in authorizing violations of the ordinances, the Commission states that these special orders granting special privileges practically nullify the value of the ordinances. For the year ending Apr. 29, 1912, about 350 such orders were issued, most of them permitting violations in congested districts where the danger is greatest, and 60% of these orders had the objectionable feature of not even stating definitely what violation was permitted. The report states emphatically that "It does the city little good to have a strong building code if certain owners and builders with special 'pull' are allowed to erect buildings in violation of that code."

Conclusions

The following is a summary of the conclusions presented by the Commission, on the basis of its investigation:

1. The scope of the powers and activities of the department has not been fully comprehended until recently, and matters which affect the safety of property and persons have not been sufficiently checked.

2. The building inspection has been a weak spot. The inspection of constructions and alterations of buildings amounting to about $100,000,000 annually has been ineffectively and uneconomically performed because of lack of proper organization and fixed responsibility; and because of inefficiency, incompetency and insubordination of some of the employees of the department.

3. The evidence in the trials of some of the inspectors disclosed that the character of the men was low as to integrity and conscientiousness, the system of inspection was ineffective; bribery was countenanced by contractors, owners and inspectors; graft was practiced, and in many cases no effort was made to see that work was done in accordance with regulations and ordinances.

4. The present organization is sufficient to enforce the regulations and requirements of the building code if managed and administered properly. Observance of the provision of the code for fixed responsibility would result in effective administration.

5. The present bulding code is strong and practical, and with a few changes would be as good as any adopted in this country.

6. Special council orders allowing violations of ordinances and special privileges to select citizens have been ssued too freely, to the detriment of the city, the department and its employees.

Recommendation

These conclusions are followed by a number of specific recommendations, but many of these relate to particular local conditions and to individual changes in the code or ordinances to which no reference need be made here. Figs. 1 and 2 show the organization of the department as now existing and as recommended by the Commission. The following is a summary of the generally important features of the recommendations:

1. The city should be re-districted periodically, according to the amount of construction and inspection work in different sections; this to be done preferably at the time of least building activity.

2. The ordinances to be amended to fix the responsibility of inspection of size of rooms, window area, ventilation, lighting, etc., between the Department of Buildings and the Sanitary Bureau of the Department of Health.

3. The code to be amended so as to provide for the automatic cancellation of a building permit where the approved plans have been altered or deviated from.

4. A committee of three to be appointed by the City Council with power to decide as to action or changes necessary on the buildings on which violations were disclosed during the inqury.

5. The Department of Police to direct patrolmen to perform general inspection of an observatory character, and make daily reports of such inspection. This would eliminate almost 50% of the present building inspection.

6. No permit to be issued where plans require serious corrections until the owner or architect submits a corrected design or a new set of plans.

7. The present loose-leaf system of reports to be replaced by a reliable and permanent system, and the new permanent book record of reports to be extended to cover all kinds of inspection work. Daily reports of inspections to be required.

8. A system of recording individual

efficiency (based on actual work) to be maintained, and a permanent record kept of efficiency markings.

9. The annual inspection of existing buildings to be extended, and followed by continued inspection where violations are found until these violations are rectified.

10. The organization of the department to be completed as provided in the present building code, with a few exceptions. The work to be divided properly, and consideration given to the creation of an expert staff of three division heads (chief inspector, engineer and secretary) who would relieve the commissioner of numerous matters of detail and report directly to him. The position of deputy commissioner to be abolished.

11. The standard of examination for inspectors to be raised. Their salaries to be graded and advancement to the higher rates to be made on the basis of seniority and efficiency. Inspectors and other employees to be thoroughly instructed as to the ordinances under which they work. Notices of special rulings, changes in procedure, etc., to be given permanent record and posted on a bulletin board.

12. The appropriation for building inspection work to be divided into two parts: one for a fixed number of inspectors to work throughout the year; the other for a fixed number of months of work, to be used and assigned according to the amount of construction work under way.

13. The practice of issuing council orders to be discouraged. Before any order authorizing a departure from the ordinance is passed by the City Council, the procedure to be as follows: 1, written request to be required, with particulars of building, owner, alderman endorsing the request, and reason for desired change; 2, original plans and plans showing deviations from ordinance; 3, recommendations or decrees of department heads to be published and make permanent record; 4, the recommendation of the department head to be final, and followed by the council committee on buildings in its recommendations to the City Council.

The Rapid-transit Tunnel Project under Twin Peaks, San Francisco, southwest from the business district to the Lake Merced district, as noted in Engineering News, May 2, 1912, page 843, has been generally approved by Bion J. Arnold, who has been retained by the Board of Supervisors of the city of San Francisco to report on the various transportation problems of the city. He holds that this tunnel will bring within 30 minutes of the business district approximately 10,000 acres of new territory, 75% of which is suitable for residence, and which has been practically useless by reason of inadequate transportation.

Mr. Arnold, however, does not fully approve the plan already under consideration; he prefers a combination which gives a subway on Market St., between Valencia and Castro Sts., and a tunnel from here to the Merced district in question, with a subgrade passenger-transfer station at Seventh Ave. Blvd., just beyond the Twin Peaks, and surface-car exits at Castro St., just before the Peaks, and at Seventh Ave. He points out that the Twin Peaks enterprise should be so planned as to facilitate the most logical future connections. He favors the use of Valencia St. as a present northern terminus of the tunel-subway project, provided the immediate assessment burden is not too heavy. The tunnel through the hill is recommended to be a 19- or 20-ft. arch-roof bore, but under Market St. a flat-roof subway section, suitable for third-rail operation and enlarged sufficiently to permit of trolley operation temporarily with station platforms 15 ft. below the street's surface. The interurban cars for this line would be equipped with third-rail contact, for use through the tunnel, but after leaving the Valencia St. subway section under Market St. would be diverted to the surface, passing down Mission St. to the harbor. The suburban expresses would be routed the same way, using a trolley on Valencia St. Suburban local cars would rise at Castro St. and proceed to the ferry by surface lines on Market or Mission Sts. The surface local lines would enter on an incline at Castro St., transfer passengers and return out by an underground loop rising to the street again.

To meet future rapid-transit necessities, additional track space for through express service exclusively, would be provided for in the acquisition of property rights for the tunel under consideration.

A Butting Collision between a light engine and a freight train on the Canadian Pacific Ry., at Nipegon, Ont., on June 14, resulted in the deaths of both enginemen, the fireman of the freight train and a brakeman.

In a Collision of a Passenger Train with a string of freight cars on the Central of Georgia R.R., at Everette, Ga., on June 14, 19 persons were injured.

A Swedish Railway Accident, on June 16, near Linkoeping, Sweden, was caused by the collision of a fast mail train and a freight train. Twenty persons are reported killed and 14 others suffered severe injuries.

A Broken Rail is ascribed as the cause of the wreck of a passenger train on the Chicago & Alton R.R., June 8, eight miles south of Bloomington, Ill. The entire train was derailed and two coaches were overturned. About 20 persons were injured.

A High Voltage Electric Current killed three linemen employed by the Public Service Corporation of New Jersey, in Elizabeth, N. J., on June 14. Four linemen were near the top of a 60-ft. transmission-line pole, adjusting a steel cross-arm. In some manner either the body of one of them or the cross-arm came in contact with a wire reported to be carrying current under some 13,000 volts. Two of the workmen were killed in attempting to rescue the first. The bodies were thrown across the high-tension wires in such a way as to charge all the wires with a heavy voltage, so that it was necessary to shut off the power in order to remove them.

A Grade Crossing Accident, on the Central R.R. of New Jersey, at Lincoln, N. J., on June 17, caused the deaths of two automobile passengers and serious injuries to a third. The automobile was struck by an observation engine on which were C. W. Huntington, General Superintendent of the Central R.R. of New Jersey, and the Division Superintendent, E. E. Kerwin. The crossing is an open one and the engineer of the locomotive affirms that he sounded the whistle on approaching it.

A Grade Crossing Accident, near Harbor Creek, Penn., on the Lake Shore & Michigan Southern R.R., resulted in the deaths of T. H. Snider, a manufacturer of Cincinnati, Ohio, and his bride of a few weeks. The chauffeur and one other passenger were seriously hurt. The crossing is on a long tangent of almost level track and is considered locally to be a particularly hazardous one.

Violent Windstorms in the Middle West did severe damage both to life and property, on June 15 and 16. In Kansas City, Mo., two persons were killed and several thousand dollars' worth of property was destroyed. At Zanesville, Ohio, the wind blew over the 75-ft. steeple of the St. Thomas Catholic Church and caused the deaths of two of the 600 persons attending the services, and caused serious injuries to many others. In western Pennsylvania, eastern Ohio and West Virginia much damage was done by lightning as well as by the wind.

A Railway Accident, on the New York Central & Hudson River R.R., on June 16, near Amsterdam, N. Y., was caused by a derailed eastbound freight train colliding with the westbound express No. 3. Several freight cars were derailed by broken wheel flange and thrown from the track on a curve just at the moment when the express was passing at high speed. The engine of the express train was thrown from the track and turned over on its side in the ditch. A baggage car, three mail cars and three passenger coaches also left the track, but remained upright. The fireman of the express was scalded to death but the engineman was not seriously hurt. No passengers were injured.

Personals

Mr. N. H. Emmons, formerly with the Tennessee Copper Co., has opened an office in the Union Oil Bldg., Los Angeles, Calif., as a consulting mining engineer.

Mr. W. L. Blair, Superintendent of Transportation of the New York, Chicago & St. Louis R.R., has been promoted to be Assistant to the General Manager, a newly created position.

Mr. E. S. McCandliss has been appointed Instructor in civil engineering at the Missouri School of Mines, Rolla, Mo. Mr. McCandliss is a graduate of Purdue University, class of 1908.

Mr. F. H. Newell, M. Am. Soc. C. E., Director of the United States Reclamation Service, has been given the honorary degree of Doctor of Engineering by Case School of Applied Science, Cleveland, Ohio.

Mr. Frederick A. Pelter, until recently Superintendent of Construction of the Tennessee Coal, Iron & R.R. Co., is now Assistant Engineer for the H. Koppers Co., of Chicago, Ill., in charge of new construction work.

Mr. R. W. Mitchener, Division Superintendent of the New York, Chicago & St. Louis R.R., at Cleveland, Ohio, has been promoted to be Superintendent of Transportation, succeeding Mr. W. L. Blair, promoted, as noted elsewhere.

Mr. B. V. Wright, Engineer of Maintenance-of-Way of the New Orleans, Mobile & Chicago R.R., has been promoted to be Chief Engineer, and will have charge of extensive reconstruction work already undertaken by the company.

Mr. C. E. Grunsky, M. Am. Soc. C. E., President of the American Engineering Corporation, of San Francisco, Calif., has been appointed Acting City Engineer of that city during the illness of Mr. Marsden Manson, M. Am. Soc. C. E., City Engineer.

Mr. H. R. Macmillan has been appointed Chief Forester of Canada. Mr. Macmillan is a native of Ontario and is a graduate of the forestry course at Yale University. He has been in the Canadian forestry service for a number of years.

Prof. W. C. Hoad, Assoc. M. Am. Soc. C. E., Professor of civil engineering at the University of Kansas and Engineer of the Kansas State Board of Health, has been appointed Professor of sanitary and municipal engineering at the University of Michigan.

Mr. Manley Osgood, of Lima, Ohio, has been appointed City Engineer of Ann Arbor, Mich. Mr. Osgood is a graduate in civil engineering of the University of Michigan, and has had charge of construction work for the Lima Gas Co., and the Standard Oil Co., at Lima.

Mr. Osgood F. Barnes, M. Am. Soc. C. E., Division Engineer of the Erie R.R., at Susquehanna, Penn., has been appointed Trainmaster of the Delaware and Jefferson divisions in addition to his duties as Division Engineer in charge of maintenance-of-way and structures.

Mr. A. E. Foreman, Assoc. M. Can. Soc. C. E., of the Supervising Engineer's office, Dallas Road Sea Wall, Victoria, B. C., has been appointed Assistant City Engineer of Victoria, under Mr. C. H. Rust, M. Can. Soc. C. E., recently City Engineer of Toronto, now City Engineer of Victoria.

Mr. Frederick M. Chase, M. Am. Inst. M. E., Assistant General Manager of the Lehigh Valley Coal Co., has been elected Vice-President and General Manager, succeeding Mr. S. D. Warriner, whose election as President of the Lehigh Coal & Navigation Co. was noted in our issue of last week. Mr. Chase began his work with the Lehigh Valley Coal Co. about 30 years ago, and has remained with the company continuously since that time.

Mr. J. H. Flynn, Jr., who has been engaged in work on the Panama Canal since 1905, has resigned his position as Mechanical Engineer for the Isthmian Canal Commission, and has been elected President of the Lines Flynn Co., Inc., of 50 Church St., New York City, of which Mr. E. M. Lines is Secretary and Treasurer. The company is engaged in jobbing manufacturing, repairing and selling railway and contractor's equipment, etc.

Mr. M. V. Hynes, Engineer of Maintenance-of-Way of the Cincinnati, Hamilton & Dayton Ry., at Cincinnati, Ohio, has been appointed Superintendent of the Wellston and Delphos divisions, with headquarters at Dayton, Ohio. The jurisdiction of Mr. H. B. Dick, Engineer of Maintenance-of-Way of the Baltimore & Ohio R.R., at Cincinnati, has been extended to include the Cincinnati, Hamilton & Dayton Ry., which is a subsidiary of the B. & O.

Obituary

Eli H. Janney, inventor of the Janney car coupler, died at his home in Alexandria, Va., on June 16, aged 80 years. He was Major and field quartermaster on the staff of Gen. Robert E. Lee, C. S. A., during the Civil War.

George A. O. Ernst, the head of the Boston, Mass., Bureau of Municipal Research, died on an eastbound train from Chicago, Ill., near Batavia, N. Y., on June 13. He was a lawyer, a graduate of Harvard University and of Harvard Law School. He was in his 62nd year.

James H. Kinkead, inventor of the Kinkead mills, a process for treating low-grade silver ore on the Comstock lode in Nevada, died at Reno, Nev., on June 9. He was 69 years old and a native of Ohio. For 50 years he had made his home in the mining districts of California and Nevada.

Alfred E. Carter, M. Am. Soc. C. E., Resident Engineer of the Rapid Transit Subway Construction Co., of New York City, died at his home in New York City on June 11 from cerebral hemorrhage. Mr. Carter was a graduate of the University of Nebraska and of Columbia University, and for the last few years had had charge of important subway work in New York City.

William J. Hunker, a former City Engineer of Allegheny, Penn., died on June 13, at Hoboken, N. J. He was born in Pittsburgh, Penn. He served four years as City Engineer of Allegheny and was afterward connected with the Allegheny County Light Co., and with the automobile department of the Studebaker Co., of South Bend, Ind. For the last few years he had been Manager and Superintendent of the York-Haven Water and Electric Power Co., at York, Penn. He was 45 years old and leaves a widow.

William Northrop, President of the Virginia Light & Power Co., the Norfolk Ry. & Light Co., the City Gas Co., of Norfolk, the Fredericksburg Power Co., the Fredericksburg Electric Co., Vice-President of the Richmond & Chesapeake Bay Ry. Co., and a director of various other industries, died at his home in Richmond, Va., on June 11, as a result of injuries received some two weeks before in an automobile accident. Mr. Northrop was born in Canadensis, Penn., in 1869, and was a nephew of the late Jay Gould. He was educated at Wyoming Seminary and at New York University. He early showed marked executive ability and had long been the manager and representative of the Gould interests in Virginia. He was a brother-in-law of Prof. Charles H. Snow, M. Am. Soc. C. E., Dean of the School of Applied Science, of New York University.

Engineering Societies

COMING MEETINGS

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 25-28. Annual convention at Boston, Mass. Secy., F. L. Hutchison, 33 West 39th St., New York.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 25-28. Annual convention at Seattle, Wash. Secy., C. W. Hunt, 220 West 57th St., New York.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 26-28. Annual meeting at Boston, Mass. Secy., H. H. Norris, Cornell University, Ithaca, N. Y.

SOCIETY OF AUTOMOBILE ENGINEERS.
June 27-29. Summer meeting at Detroit, Mich. Secy., C. F. Clarkson, 1451 Broadway, New York.

NATIONAL MUNICIPAL LEAGUE.
July 8-12. Annual meeting at Los Angeles, Calif. Secy., C. R. Woodruff, North American Bldg., Philadelphia, Penn.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 11-12. Summer meeting at Detroit, Mich. Secy., W. W. Macon, 29 West 39th St., New York.

OHIO ELECTRIC LIGHT ASSOCIATION.
July 16-19. Annual convention at Cedar Point, Ohio. Secy., D. L. Gaskill, Greenville, Ohio.

New England Water Works Association—The June outing will be held at the Cape Cod Canal, June 26. The Boston Society of Civil Engineers have been invited to join the party and a special train will leave Boston at 9:30 a.m.

Milwaukee Engineering Society—A joint banquet was held, on June 12, with the Milwaukee branch of the American Institute of Electrical Engineers, at which T. E. Barnum, M. Am. Inst. E. E., gave an illustrated lecture on the Panama Canal. The following officers of the society were elected: President, Henry Weickel; Vice-President, Emil A. Vilter; Secretary, Louis E. Bogen, and Treasurer, M. A. Beck.

New York Electrical Society—At the annual meeting, held on June 12, the following officers were elected: President, Henry L. Doherty; Vice-Presidents, A. L. Doremus, Frank W. White and Dr. Edward C. Titus; Secretary, George H. Guy; Treasurer, Herbert S. Spencer. The meeting was preceded by a dinner, after which Mr. Augustus Post gave an illustrated talk on his various balloon experiences. Mr. Earle L. Ovington gave a lecture on "Aëroplane Wireless and the Problem of the Modern Flying Machine."

American Road Congress—This congress is to be a consolidation of the conventions of some 40 road associations of the United States and will meet at Atlantic City, N. J., from Sept. 30 to Oct. 5. Among the associations represented will be the American Association for Highway Improvement and the American Automobile Association. The National Association of Road Machinery and Material Manufacturers has voted to hold its exhibition of materials and equipment in conjunction with the congress. The United States Office of Public Roads will exhibit a complete set of miniature models illustrating every known type of road construction and working models of road making machinery operated by miniature electric motors. The U. S. Government has loaned its collection of models showing the various stages in the development of transportation.

The first two days of the congress will be assigned to the road users under the auspices of the American Automobile Association, the second two days to problems of legislation, finance and economics under the auspices of the American Association for Highway Improvement, while the last two days will be given up to the engineers who will discuss problems of construction and maintenance, and to the various associations which will meet and map out their plans of action.

The honorary President of the congress is President Taft, the active President, Logan Waller Page, Director of the U. S. Office of Public Roads, and Lee McClung, Treasurer of the United States, is Treasurer of the congress.